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A MANUAL

OF

OPERATIVE SURGERY.

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BY

LEWIS A. STIMSON, B.A., M.D.,

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IN THE MEDICAL FACULTY OF THE UNIVERSITY OF THE CITY OF NEW YORK,
CORRESPONDING MEMBER OF THE SOCIÉTÉ DE CHIRURGIE, OF PARIS.

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TO

PROFESSOR WILLIAM H. VAN BUREN,

IN RECOGNITION OF HIS EMINENT MASTERY

OF THE ART AS WELL AS THE SCIENCE OF SURGERY,

AND TO

DR. EDWARD L. KEYES,

IN AFFECTIONATE REMEMBRANCE OF A PERSONAL FRIENDSHIP

UNINTERRUPTED FOR TWENTY YEARS,

AND OF AN

INTIMATE ASSOCIATION IN MUCH PROFESSIONAL WORK,

This Volume

IS INSCRIBED BY

THE AUTHOR.

PREFACE TO THE SECOND EDITION.

In preparing the second edition of this Manual I have sought to indicate the changes that have been effected in operative methods and procedures by the adoption of the antiseptic method of treating wounds, and to describe such additions and substitutions as have been favorably received and can be systematically presented.

The descriptions of most of the formal operations that can be rehearsed upon the cadaver remain unchanged; the chief alterations and additions will be found in the passages treating of the excision of joints and bones, and of operations in which the peritoneal cavity is opened.

LEWIS A. STIMSON.

New York,
34 East Thirty-third Street.
November 9, 1885.

PREFACE TO THE FIRST EDITION.

In preparing this Manual, I have sought to render it sufficiently complete, as regards both the number of operations described and the details of the descriptions, to meet the wants of the practitioner and of the student; but, on the one hand, I have excluded operations, such as the removal of tumors, which can be described only in general terms; and, on the other, I have tried to avoid that minuteness of detail in non-essentials, which Mr. Syme condemned so vigorously in the teaching of the present day, as "the fiddle-faddle instructions, not only for using, but even for holding, the knife, which sufficiently denote the poverty of intellect whence they proceed, and the lowness in aspiration to which they are addressed." Whenever a knowledge of details, however, has seemed essential to the correct understanding and performance of an operation, I have not hesitated to describe them very fully, and the same principle has governed the introduction of descriptions of the anatomical relations of the parts.

It goes without saying that in the preparation of a work of this character very large drafts must be made upon the results of the labor of others, and that the efforts of the writer must be limited, except on rare occasions, to making judicious selections and judicial comparisons. The list of methods and processes is now so large that the surgeon is more likely to advance the science and art of his profession by elaborating the materials and mastering the results already acquired, than by inventing new practices or reinventing old ones. It is not desirable, even if it were possible, to include in a manual every operation, and still less every modification, that has been suggested, and it has been my aim, therefore, either to select for description in each case that method or process which seemed the best, and then simply to indicate the variations which came well recommended, or which might be required under exceptional circumstances, or else fully to describe methods which differed radically from each other, and then to indicate their respective merits and disadvantages. It is only proper to add that in making such selections and comparisons, I have not relied solely upon my own judgment and experience, but have fortified them by reference to the practice and opinions of acknowledged leaders in the profession.

Whenever it was practicable, I have gone to original sources; and, while not making the question of priority in the invention of any method a prominent one, or spending much time in solving it, I have placed the credit where it seemed to belong, and have given references to the authority, so that any error can be readily corrected.

The works most freely consulted have been those by Sédillot, Velpeau, Guérin, Bell, Dubrueil, and Chauvel on Operative Surgery; Ollier and Von Langenbeck upon Excisions; Buck and Verneuil upon Plastic Surgery; Wells on the Eye; Roosa on the Ear; Van Buren and Keyes on the Urinary Passages; Peaslee on Ovariotomy; Thomas on Diseases of Women; Tillaux and Richet on Topographical Anatomy, and the Bulletins de la Société de Chirurgie.

Many of the illustrations are modifications of those in Dubrueil, Chauvel, and Tillaux; others have been taken from Holmes's and Erichsen's Surgeries, Wells, Thomas, Wood on Rupture, and Wales on Bandaging; and a few representing instruments have been furnished by Tiemann and Reynders.

I have to thank Dr. Vandervoort, the accomplished librarian of the New York Hospital, for many facilities afforded me by him, and Dr. Keyes, Dr. Roosa, and the late Dr. Peaslee, for their kind revision of portions of the manuscript.

LEWIS A. STIMSON.

72 Madison Avenue, N. Y., June 7, 1878.

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OPERATIVE SURGERY.

PART I.

THE ACCESSORIES OF AN OPERATION.

ANÆSTHESIA.

Local anæsthesia may be obtained (1) by the action of cold, or (2) by the application of an agent which exerts locally a benumbing effect upon the nerves.

(1) The low temperature which produces local anæsthesia may be obtained by the application to the parts of a freezing mixture (ice and salt), or by the vaporization of ether. The former is applicable to larger surfaces than the latter. A mixture of cracked ice and salt is put in a muslin bag and laid upon the part, and a folded compress or towel laid over it to intensify its action. After it has been in place two or three minutes it should be removed, the sensibility of the skin tested, and the bag reapplied if the desired effect has not been produced. When chilled to insensibility the skin is white and puffy.

When ether is used for local anæsthesia it should be directed upon the parts in a fine spray, or its rapid vaporization should be aided by fanning or blowing upon the surface. It is inefficient when the skin is very vascular.

(2) Carbolic acid is an efficient and convenient means of producing local anæsthesia. A cloth thoroughly wet with a three per cent. solution of the acid should be kept upon the skin for fifteen minutes, and then the undiluted acid applied with a brush along the line of the proposed incision. This is applicable to the opening of abscesses, felons, etc., and to many minor operations.

Hydrochlorate of Cocaine.—The injection under the skin or into a nerve of a few drops of a two or four per cent. solution of the hydrochlorate of cocaine produces a temporary local anæsthesia, sufficient to permit the painless performance of an operation involving only the skin or the layers immediately underlying it. A deeper injection into a nerve produces anæsthesia of the region supplied by it. As this agent acts upon the nerve-fibres, the injection should be made on the proximal side of the region to be operated upon, and should be directed toward and into that region.

General Anæsthesia.—The agents in common use for producing general anæsthesia are (1) ether, (2) chloroform, and (3) nitrous oxide.

The great merit of ether is in safety. Chloroform is more rapid in its action at first, as usually given, at least, less liable to cause vomiting, less disagreeable in its after-effects, but it is certainly more dangerous. On account of its inflammability, ether should be used with caution at night, and as its vapor is heavier than air, the lights should be held above the bed. Nitrous oxide is suitable only for very short operations. Its use to obtain anæsthesia for any length of time is as dangerous as that of chloroform, perhaps more so.

Ether endangers life through suffocation, which may be the result of paralysis of the respiratory muscles, or of obstruction of the air-passages by the tongue, or by a foreign body, such as vomited matter. Chloroform kills by exerting a special influence upon the ganglionic nerve-centres presiding over respiration and circulation. Arrest of the breathing and lividity of the surface give timely notice of danger from ether. Chloroform may kill without a moment's warning.

If during anæsthetization by ether the respiratory muscles cease to act, artificial respiration should be kept up, and stimulants administered; but the patient should be kept quiet, should not be whipped or excited to muscular action. The danger comes from the weakness of his muscles, and they must not be called upon for any extra exertion. If, as is much more common, the diaphragm acts, but the air-passages are obstructed, and the face becomes livid, the obstruction must be removed, and the breathing will then take care of itself. If the obstruction is due to the presence of a foreign body in the glottis or trachea (false teeth, vomited matter), the shoulders and head must be lowered, and the hips raised. It may become necessary to resort to tracheotomy. If the obstruction is due to the falling back of the tongue in consequence of the relaxation of the muscles of the pharynx and floor of the mouth, a stout piece of wood should be put between the patient's teeth and his tongue drawn forward. The most prompt and efficient way of doing this is for the operator to hook the terminal joint of his forefinger behind the root of the tongue and draw it forward, or the fingers should be pressed upward and inward from below the angles of the jaw.

When operating upon the mouth and nasal passages, hemorrhage may interfere seriously with respiration and anæsthetization. By placing the patient on his back, and allowing his head to hang down over the end of the operating table, the blood will be made to flow away through the nostrils, and the larynx will remain clear.

During the inhalation of chloroform, death may occur either suddenly by syncope, or more slowly with signs of cerebral congestion and arrest of hæmatosis. In the first case the heart stops, the patient becomes pale, the respiration superficial; the other usually happens after consciousness has returned, the face suddenly becomes livid, the patient loses consciousness again, and dies within half an hour. In the first variety, death can generally be averted by lowering the head, slapping the breast and face with wet towels, and applying the galvanic or faradic current. When the galvanic current is used, the negative pole may be placed in the mouth, and the positive pole at the anus. The faradic current should be applied only over the chest; its application to the phrenic or pneumogastric nerves in the neck is dangerous. In the second variety death is apparently inevitable.

By the inhalation of nitrite of amyl impending death may sometimes be averted.

Administration of the Anæsthetic.—Chloroform should be given upon a compress folded twice longitudinally and once transversely, so as to be about six inches square. The upper fold is then thrown back, a drachm of chloroform poured upon the lower one, and the upper one replaced to prevent evaporation from that side. The compress is then held before the mouth and nostrils of the patient, and whenever necessary the upper fold is thrown back, and additional chloroform poured upon the lower one. No special instrument is needed to prevent the administration of too much at a time. It has been demonstrated that the amount of the vapor of chloroform in the air never exceeds 4½ per cent.

To give ether successfully three points must be provided for: the evaporating surface must be large, the air inspired by the patient must pass across it, the supply of ether must be abundant so as not to require frequent renewal. The ordinary cone, with certain modifications, meets these wants very well. Three or four thicknesses of stout brown paper, or ten of newspaper, measuring twelve by fifteen inches, should be covered with a thick towel well pinned on, and rolled into the form of a cone, a foot long and five inches in diameter, and fastened with long pins. A hole should be left at the apex of the cone large enough to admit the little finger, and the corners at the base should be turned back. If the towel is thick it will hold all the ether that is needed, and if the base is pressed closely against the chin, cheeks, and nose, all the air breathed by the patient will have to enter by the hole left at the apex, and pass across the large evaporating surface of the inside of the cone. If the cone is held at first at a short distance from the mouth and then brought gradually nearer, complete anæsthesia may often be obtained in two or three minutes without having caused any strangling, or provoked any resistance.

Rectal Etherization.—It was shown by Mollière, in 1884, that general anæsthesia could be readily obtained by the administration of ether by the rectum. The method was at once widely tried but has been abandoned, except in special cases, for it was found to be more dangerous than the method by inhalation. The dangers are that the anæsthetization may unwittingly be made too profound and prolonged, and that the contact of the ether with the intestinal mucous membrane may cause a bloody diarrhœa.

The ether is placed in a bottle provided with a tightly fitting cork through which passes a rubber tube. The free end of the tube is inserted in the rectum, and the bottle placed in warm water.

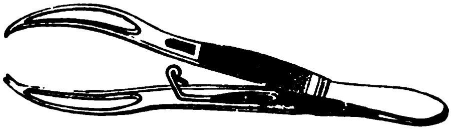
The precautions to be observed are that the water should not be warmer than 100° Fahr., and that as soon as anæsthesia is obtained the tube should be withdrawn from the rectum, to be reapplied if necessary. The tube should be large, and should extend downward from the anus to the bottle without loops or coils in which the ether might condense.

ARREST OF HEMORRHAGE.

Hemorrhage is arrested: (1) by ligature; (2) by torsion; (3) by temporary mechanical occlusion, without injury to the walls of the vessels (acupressure, forcipressure); (4) actual cautery; (5) coagulating applications; (6) cold or heat.

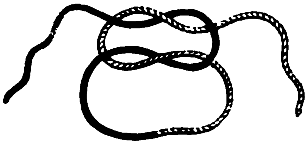
Ligature.—The ordinary ligature is made of waxed silk or catgut, and is applied by seizing the end of the vessel with artery forceps (Fig. 1), drawing it slightly from its sheath, and then throwing the ligature about it. The knot should be a simple "square knot" (Fig. 2), and should be drawn tight. Instead of forceps, a tenaculum may be used, and the ligature thrown over its point. The great objection to the silk ligature, unless antiseptic, is that it acts as a foreign body in the wound, and must be thrown off by sup-

FIG. 1.



Artery forceps.

FIG. 2.

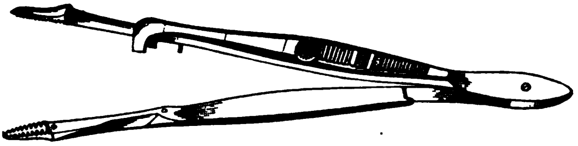


Square knot.

puration. The catgut ligature is free from this objection; it dissolves promptly without causing suppuration, and yet it occludes the vessel for a sufficient length of time.

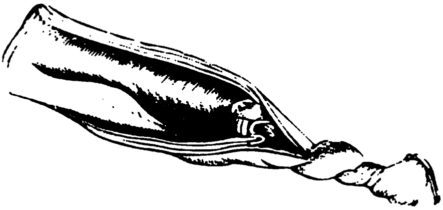
Torsion.—The end of the artery should be seized with a pair of self-fastening flat-bladed forceps (Fig. 3), slightly drawn from its sheath, and twisted until it parts. Care must be taken not to include much of the adjoining tissues in the grasp of the forceps. Torsion has been successfully applied even to the femoral artery, but occasionally severe secondary hemorrhage has followed. Its advantage over the silk ligature is that it leaves no foreign body in the wound, but, in this respect, it is not superior to catgut. It is not in general use except for small vessels.

FIG. 3.



Torsion forceps.

FIG. 4.



Effect of torsion upon the coats of an artery.

Acupressure, Forcipressure.—The principle of acupressure is to compress the vessel (Figs. 5, 6, 7) at a short distance from its cut end against the neighboring tissues by means of a pin passed under it. The pressure may be increased by giving the pin different directions at different parts of its course, so as to twist the tissues, or by passing a loop of annealed wire over it. The pins should be withdrawn at the end of forty-eight hours. The device of leaving a tenaculum in place for a day or two, when a ligature will not hold after its withdrawal, is a kind of acupressure.

FIG. 5.

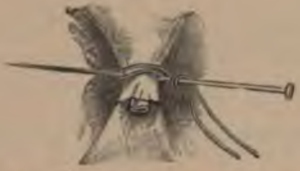


FIG. 6.

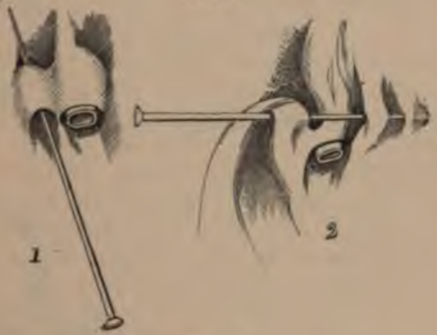
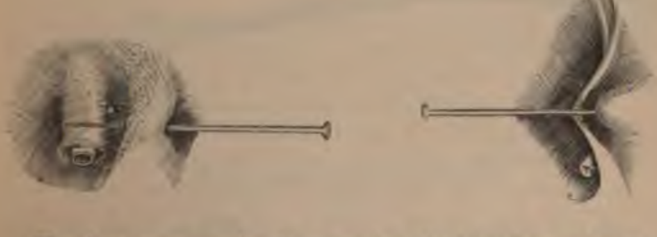
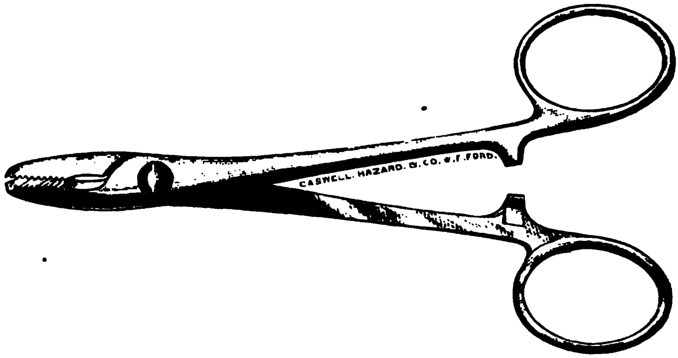


FIG. 7.



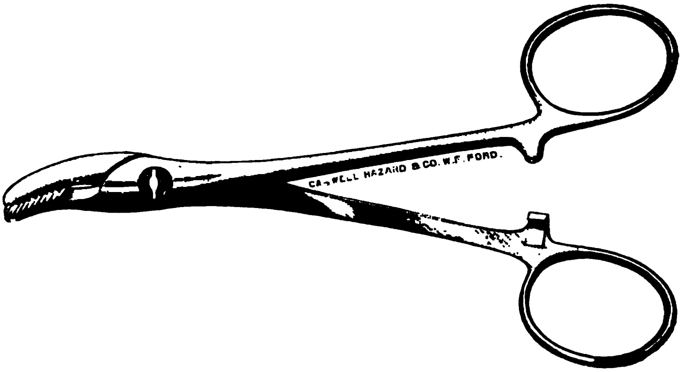
Forcipressure consists in grasping the bleeding point with a pair of self-fastening forceps, and leaving them in place, without using a ligature. This method is commonly used for the prompt arrest of bleeding during an operation. When the knife is laid aside the forceps are taken up in turn and removed after a ligature has been thrown about the tissues grasped by them.

FIG. 8.



Self-holding hæmostatic forceps.

FIG. 9.



Self-holding hæmostatic forceps; curved.

Actual Cautery.—This is a very efficient and prompt hæmostatic; it may be applied as well to oozing surfaces as to bleeding points which cannot be tied.

Of *Coagulating Applications* it is necessary to mention only the liquor ferri subsulphatis. It may be applied directly to the raw surfaces, or upon a tampon of charpie, or a sponge.

Cold.—A stream of ice water or very hot water will stop all oozing very promptly. A convenient method of applying heat is by towels wrung out in hot water.

Posture.—Elevating the limb will often stop oozing.

ARTIFICIAL ISCHÆMIA.

Loss of blood during an operation upon a limb may be prevented by pressure upon the main artery on the proximal side of the incision. This pressure may be made with the finger, tourniquet, or elastic cord.

The tourniquet (Fig. 10) is composed of a pad, band, and screw; by turning the screw the band may be tightened at will. The principle of its application is the compression of the artery against the underlying bone. A point should be selected in the course of the artery where such compression can be made; a roller bandage, an inch in diameter, placed over the vessel, and parallel to its course, the tourniquet then applied as shown in Figs. 11 and 12, and the screw tightened. Some surgeons prefer to place the pad of the tourniquet upon the roller bandage itself, and not on one side as shown in the figure. The buckle on the band should always be much further from the roller than is represented in the figures.

The elastic bandage, introduced by Esmarch and known by his name, is intended to render an operation entirely bloodless by forcing all the blood out of the limb, and then preventing the entrance of a fresh supply. By its aid an operation can be performed upon the living body with as much ease and certainty as upon the cadaver, and it is now used very generally whenever careful dissection is necessary, the limits of a carious process are to be determined, or when loss of blood is to be avoided. The bandage is made of elastic webbing, or vulcanized rubber, two inches broad, and is applied spirally from the extremity of

FIG. 10.

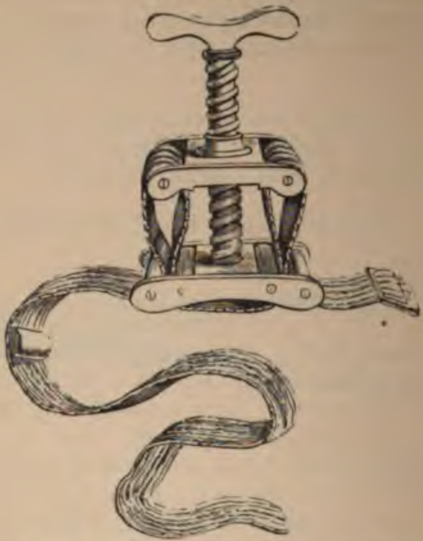


FIG. 11.

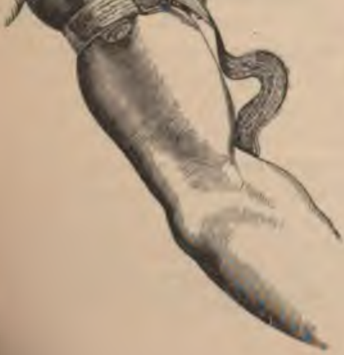
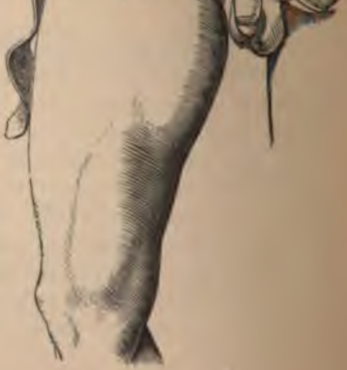


FIG. 12.



the limb to a point three or four inches above the proposed incision. A stout, but not too hard, cord of India rubber is then wrapped two or three times about the limb, at the upper limit of the bandage, and secured by a *single* knot, and the bandage then removed. Care should be taken not to apply the cord with too much force. When the operation is ended, the cut ends of all the vessels that can be detected should be secured before the cord is removed. After its removal, any that escaped detection are tied, and the oozing arrested with very hot or cold water.

ANTISEPTIC TREATMENT OF SURGICAL WOUNDS.

Most of the causes of the mortality of surgical operations originate in a prolongation of the process of repair and the attendant suppuration. Anything, therefore, which shortens the time occupied by this process, which promotes early union, and prevents or restrains suppuration, adds to the chances of the patient's recovery. Among the principal obstacles to early union may be reckoned the putrefaction of the secretions from the cut surfaces, and their retention, in large or small quantities, within the wound. It has been demonstrated that putrefaction is the result of the presence of living vegetable organisms, which are always found in the air, and which act as ferments in liquids capable of putrefaction. The problem then is to rid the wound at the end of an operation of all such living ferments and of others capable of producing a specific infection, and to prevent their presence and growth in the discharges while still in contact with the wound.

The first method by which it was sought systematically to accomplish these ends was the "antiseptic method" introduced by Prof. Lister, then of Edinburgh, now of London. It has since undergone many modifications in its details, but the original underlying principle is so firmly established that every proposed modification will be unhesitatingly judged by its degree of conformity with it.

The cardinal points are, 1st, to make and keep the wound surgically clean; 2d, to provide for the escape of its secretions as rapidly as they form; 3d, to exert a uniform, moderate pressure upon it, undisturbed by frequent changes of dressings.

The first point is now generally met by the use of solutions of corrosive sublimate to wash the wound and the adjoining surfaces and in the preparation of the dressings; the second by drainage tubes of rubber or decalcified bone, or by counter-openings, or by turning in the edge of the wound at one or two places and suturing it to the deeper parts; the third by thick soft dressings of purified, antiseptic gauze, cotton, peat, peat-moss (sphagnum), or sawdust.

All instruments that are to come into contact with the wound should be cleaned by washing and scrubbing, and by boiling if they have previously been in contact with infectious discharges, and should be kept during the operation in an antiseptic solution; the one in common use is a watery solution of carbolic acid of the strength of 1 in 20. Corrosive sublimate cannot well be used for this purpose because of its injurious action upon metal.

Two watery solutions of corrosive sublimate are needed, 1 to 1000, and 1 to 5000; the first for the disinfection of the hands of the surgeon, the skin of the patient, sponges, drainage tubes, and preëxisting wounds; the second, 1 to 5000, for washing the wounds made by the surgeon in healthy, uninfected tissues. This washing may be made continuously during the operation, or interruptedly, or only at its end before the wound is closed. If cutting is done through parts that are not certainly healthy the stronger solution should be used at intervals. Neither solution should be used in large natural cavities, as the abdomen, or the mouth or rectum.

Catgut is prepared by winding it on large spools and placing it in the 1:1000 solution for 12 hours, and then in 95 per cent. alcohol for the same length of time. It is then ready for use, and may be kept indefinitely in the alcohol without deterioration. The thicker sizes, thus prepared, will remain undissolved in the tissues for more than a week, and can be safely used for ligatures en masse, and even for tying the pedicle in ovariotomy or hysterectomy. It can also be safely used for sutures where the tension is not great, and the common practice now is to use it as a continuous suture, because of the rapidity with which the wound can thus be closed, and because its tendency to cause scarring is then less.

Drainage tubes are made of India rubber (the red rubber is the best) ¼ or ⅜ inch in diameter, with large lateral openings at every inch. They should be cut off almost level with the skin, and prevented from slipping in or out by a safety-pin transfixing the projecting end and by a suture fixing them to the skin.

They should ordinarily be removed after 48 hours, or at the first subsequent dressing; if, however, there is then a discharge of pus or even of slightly purulent serum, the removal should not be complete, but a short drain should be left. Bone drainage tubes, if properly made, disappear by absorption in about a week.

Dressings.—The selected material (moss, peat, etc.) is prepared by soaking in a 1:500 solution of corrosive sublimate for a few hours, then wringing it out or allowing the solution to drain away, and then making it up with bags of sublimated gauze into flat cushions of various sizes and about an inch thick, which should be kept damp until used, because when moist they absorb more readily.

Sublimated gauze or cotton is made by soaking the purified material in a solution containing 1 part of corrosive sublimate, 190 of water, and 10 of glycerine, and then allowing it to dry.

Schede very highly recommends "glasswool" for immediate contact with the sutured incision (it should not be used on an open wound) because of its softness and great power of absorption. It is made of fine spun glass, and prepared for use by soaking in a 1 per cent. solution of sublimate.

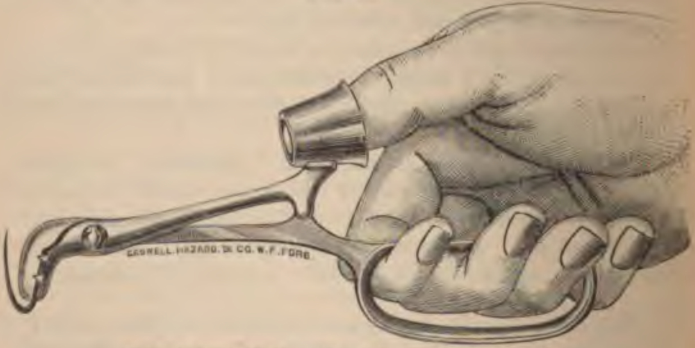
The operation is conducted as follows: The patient is placed upon a table slightly raised at the end or side to promote the escape of the water used in washing, and his body protected where necessary by rubber sheets. Cloths wrung out in the 1:1000 sublimate solution are placed about the field of operation, and the surface of this is scrubbed with soap and water, shaved if necessary, and washed with the solution.

The instruments are placed near at hand in shallow trays containing the carbolic solution, and a large flask filled with the 1:5000 sublimate solution and provided with a rubber tube and stopcock, is conveniently placed at an elevation of three or four feet above the bed. Besides holding sponges, wet towels, and the strong solution for the hands of the surgeon should be within reach.

If hemorrhage is not prevented by a tourniquet, all bleeding points should be immediately secured with self-fastening forceps which are left in place until the cutting is ended or until so many have been applied that their presence becomes an inconvenience. They are then taken up in turn, and a catgut ligature thrown about each point.

If a tourniquet is used, all recognizable vessels that have been severed are tied, then the tourniquet removed and all bleeding points caught and tied. Every effort should be made absolutely to arrest all bleeding. Some surgeons, when using Esmarch's elastic bandage, the removal of which is followed by much troublesome oozing, close the wound and complete the dressing before removing the cord, trusting to pressure to prevent oozing. This method is not proper after amputation.

Fig. 13.


CASWELL. HAZARD. & CO. N.Y. FORB

Halsted's needle-holder, with needle curved across the flat.

The bleeding having been completely arrested, the wound is thoroughly washed, drainage tubes inserted or counter-openings made, and the edges of the wound brought together with sutures. If the wound is large and irregular, it is well to fasten its deeper parts together with buried catgut sutures passed by means of a curved needle, Fig. 13, and to attach the central portions of the skin flaps to the underlying raw surfaces in the same manner. The outer surface of the skin should not be included in the loop of such a suture, for the tension is apt to cause pain.

If the skin is delicate the contact of moist sublimate dressings may cause irritation, and it is well to use as a first layer a few thicknesses of iodoform gauze; over this are placed the principal dressings, small cushions prepared as above described, or layers of gauze or cotton, arranged to make uniform pressure, and bound on with bandages of antiseptic gauze, and over these is placed a large cushion or a thick sheet of prepared cotton. An impervious outside layer, oil silk or mackintosh, is no longer used; it has proved to be better to have the discharges dry by evaporation.

Open wounds are covered with a layer of two to four thicknesses of sublimate or iodoform gauze, and then covered with the cushions or cotton or, if hollow, stuffed with crumpled gauze. When the dressing is changed the layer of gauze on the surface of the wound may usually be left in place.

SUTURES.

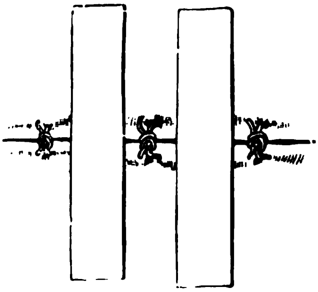
Sutures may be made of silver, silk, catgut, or horsehair. If a suture is to be retained for any length of time silver is the best material, since it does not provoke inflammation, and has but a slight tendency to cut out, unless tension is caused by inflammatory swelling. Silk answers equally well if it is to be retained for only a short time, and usually it can be removed with less pain and disturbance of the parts. If carbolized, and used in connection with the antiseptic dressing, it is as unirritating as silver. Catgut is unirritating and, if properly made and not too old, its buried portion will melt away in a few days. Horsehair is prepared by soaking in oil, which makes it pliable and diminishes its brittleness; it is useful when there is but little strain upon the parts, and when it is desirable that no marks should be left by the sutures.

Sutures can hardly be retained too long a time if an adequate exit has been provided from the first for the discharges; they keep the parts in easy contact and obviate the necessity for the frequent reapplication of strips of adhesive plaster. A serious objection to the interrupted suture in some cases is the scar which it leaves, even when it has not been allowed to cut out. The pressure of its loop upon the included tissue is a traumatism which is followed by the production of inodular tissue and a raised cicatrix in its line. The continuous, twisted, and quilled sutures are free from this objection.

1. The different kinds of suture are:

1. *The interrupted* (Fig. 14), in which each stitch is tied as it is made, and the knot left on the least dependent side.

FIG. 14.



Interrupted suture.

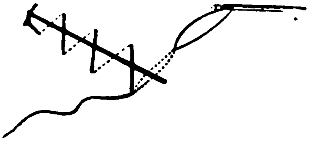
If silver is used the edges of the wound are brought into contact by drawing upon the ends of the wire, and the stitch fixed by crossing them over the incision, and giving each a half turn about the other, and then twisting them two or three times. Or the ends may be engaged in a split shot and fixed by compressing it upon them, or brought through buttons or holes in a metal plate, and then fastened together.

2. *The continuous suture* (Fig. 15), which is passed in the same manner as the interrupted, but the stitches are not cut apart and tied. It is conveniently fastened at the last by drawing it double through the last stitch and using the free end to make a knot with the double part attached to the needle.

3. *The twisted suture* (Fig. 16), made by transfixing the

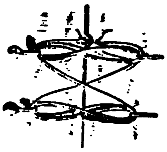
lips of the incision with a pin, about the two ends of which a stout thread is then twisted. The pins may have movable points, as shown in Figs. 17 and 18, or stout "solid-headed" pins may be used and passed either in the usual manner, or with the aid of Buck's pin-conductor (Fig. 19). Their

FIG. 15.



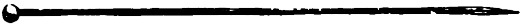
Continuous suture.

FIG. 16.



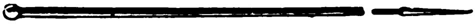
Twisted suture.

FIG. 17.



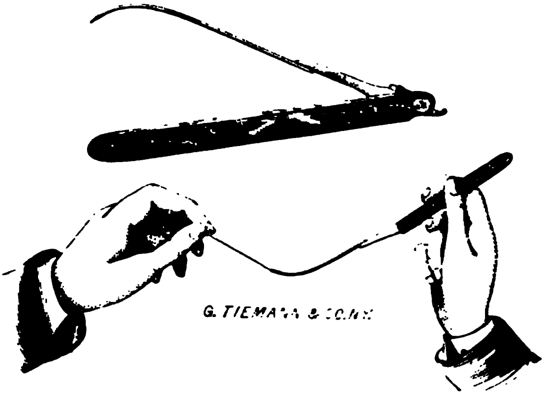
Harelip pin.

FIG. 18.



Harelip pin with movable point.

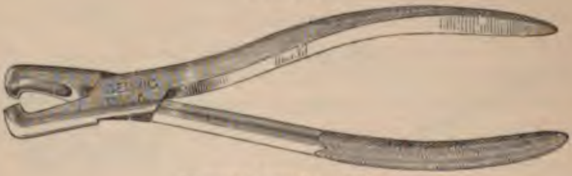
FIG. 19.


G. TIEMANN & CO. N.Y.

Buck's pin conductor.

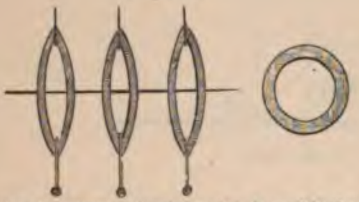
points should be cut off with nippers (Fig. 20), after they have been inserted, and the skin protected at each end by a strip of adhesive plaster. Instead of thread, a rubber ring is sometimes used (Fig. 21).

FIG. 20.



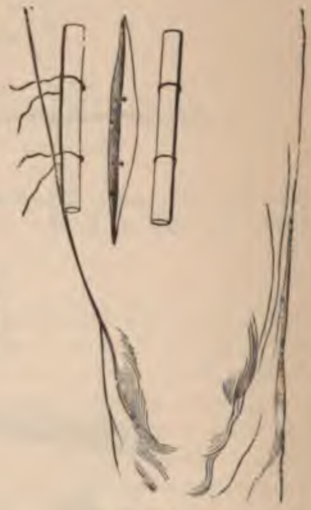
Nippers for cutting off pins.

FIG. 21.



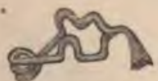
Twisted suture. A rubber ring is used in the place of thread.

FIG 22.



Quilled suture

FIG. 23.



Serre-fine.

4. *The quilled or button suture* (Fig. 22), in which the wire or thread is passed double and tied over pieces of gum catheter or ivory rods or buttons. This is employed when the tension is great, or when the deep parts tend to drag asunder, and allow the secretions to collect. The points of entry and emergence of the sutures should be at a considerable distance from the incision.

The serre-fine (Fig. 23) may be used when the tension is slight, and when the edges of the incision will not need to be held together for more than twenty-four hours. It is a small self-retaining forceps, with toothed blades, and is made of silver wire. The blades are separated by pressing upon the sides, and spring together when the pressure is removed.

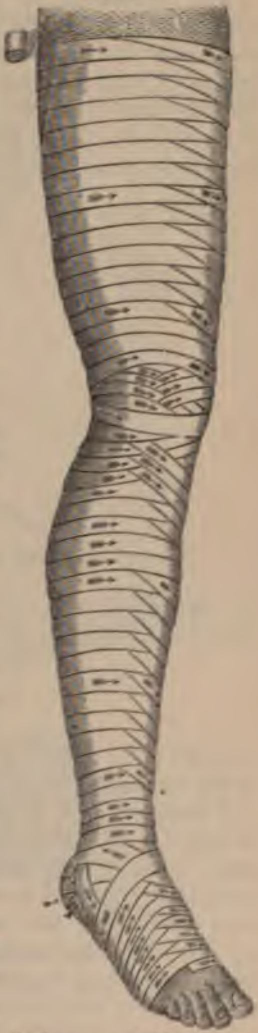
For other kinds of sutures see *Wounds of the Intestines.*

BANDAGES.

Ordinary roller bandages should be made of strips of strong unbleached muslin from 2¾ to 3¼ inches in width and about four yards long, rolled up snugly from one end. Narrower and shorter strips may be required for the smaller and more irregular portions of the body. The selvage edge should always be removed. "Double-headed" rolls are made of longer strips rolled from each end towards the middle; they are used only for compound dressings in which the turns cross each other at right angles (Fig. 30).

A bandage should be so applied that it will press evenly upon all portions of the part covered by it, and not so tightly as to cause œdema of the distal portion when applied to a limb. When firm pressure is needed at any point on a limb, the bandaging should begin at its lower extremity and be carried up to the necessary height. The methods of

FIG. 24.

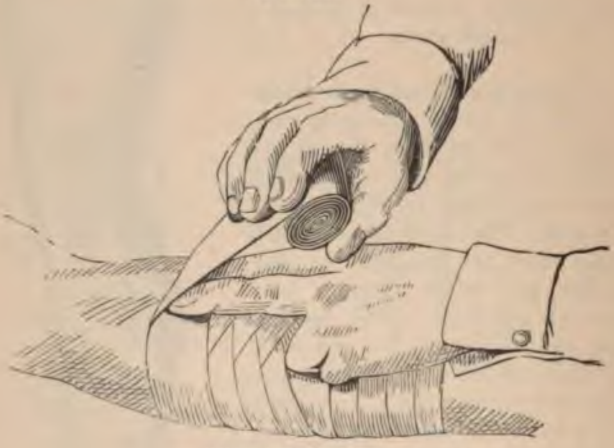


Continuous or spiral bandage.

application in common use are *the continuous* or *spiral*, *the figure of-8* or *spica*, *the* T*-bandage*, *the capelline*, and *the triangular bonnet*.

The continuous or spiral bandage (Fig. 24), when applied to a limb, should be fixed by one or two circular turns about the foot or hand, and then carried regularly up the limb, each turn covering the upper half of the preceding one. The increase in the thickness of the limb makes it necessary to *reverse* the turns in order that they may lie snug and keep their place; this is done by fixing the centre of the band with the finger (Fig. 25), and turning over that edge of the bandage which lies upon the thicker side.

FIG. 25.

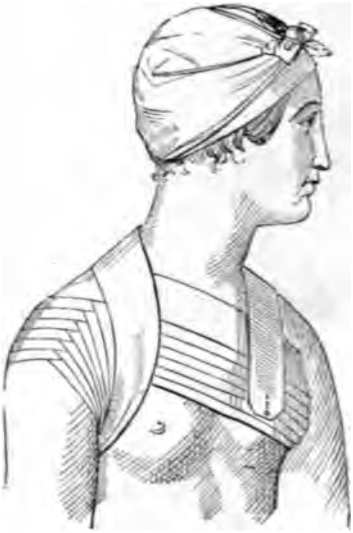


"Reversing" the turns.

The figure-of-8, or *spica*, *bandage* is represented in Figs. 26 and 27; successive turns are taken about two adjoining parts, crossing from one to the other over the point which it is especially desired to secure. At the groin the bandage is fixed by one or two turns about the thigh, then carried around behind the back and across the hypogastrium to the thigh again, and thence over the same course as often as is necessary.

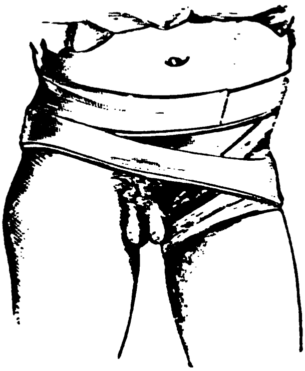
The knee, shoulder, elbow, or ankle can be dressed by means of overlapping turns of a figure-of-8 bandage, or in the manner shown in Fig. 28, by tearing an oblong piece of muslin down the middle at each end, leaving a square undivided portion in the centre. The square portion is placed over the knee, and the four ends crossed under it brought in front and tied.

Fig. 26.



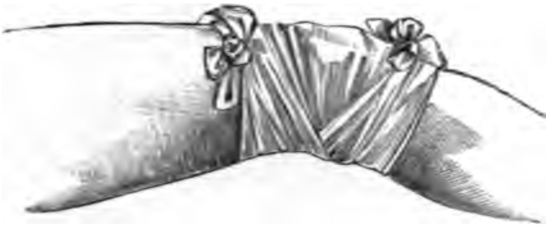
Spica of the shoulder.

Fig. 27.



Spica of the groin.

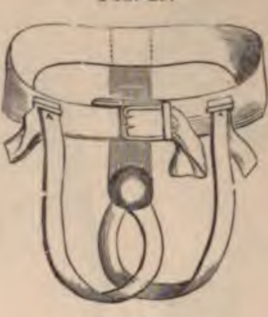
Fig. 28.



Four-tailed bandage for the knee.

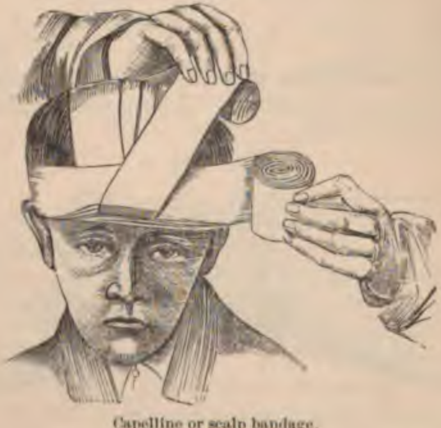
The T-*bandage* (Fig. 29) is composed of a transverse and one or two vertical bands. Sometimes the transverse band covers the dressing, and the vertical band serves only to keep the other in place; but generally the reverse is the case, and the vertical band supports a dressing or an instrument, and is itself supported by the transverse one. This bandage is most commonly employed in dressings applied to the anus, perineum, and lower portion of the trunk.

FIG. 29.



T-bandage.

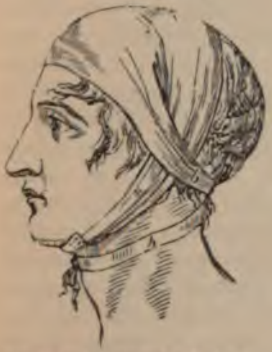
FIG. 30.



Capelline or scalp bandage.

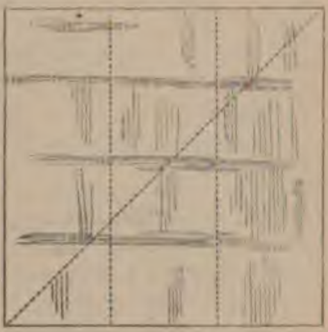
The capelline or scalp bandage (Fig. 30) is applied by means of a double-headed roller bandage, the centre of which is placed upon the forehead and the two ends carried horizontally around the head to meet at the occiput, where they cross, and the lower one is brought forward over the vertex, while the other is continued around horizontally. When they meet again in front the one that crosses the vertex is carried under the other and then back across the vertex to the occiput, and so on until the entire scalp is covered. This bandage is difficult to apply, and easily disarranged, but it is useful when pressure must be applied at several points. In other cases it may be advantageously replaced by the triangular bonnet, or four-tailed bandage (Fig. 31).

FIG. 31.



Four-tailed bandage for the head.

FIG. 32.

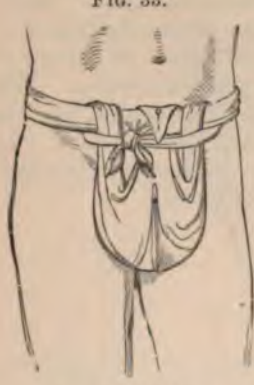


Triangular bonnet.

The triangular bonnet is made of a large square piece of muslin folded diagonally (Fig. 32). When applied to a stump the end of the limb is placed in its centre, the long folded border brought around transversely and tied, and the angle brought up in front and made fast to it. When used as a suspensory for the testicles (Fig. 33), two or three turns of a bandage are passed around the abdomen and fastened; the square angle of the triangle is made fast to this band in front, and its body brought down in front of the scrotum, carried back behind it, and the ends tied to the transverse band.

Immovable bandages are used mainly in fractures, dislocations, sprains, and after operations that have involved a joint or destroyed the continuity of a bone. They are usually made by soaking roller bandages before their application in solutions of starch, dextrine, plaster of Paris, silicate of soda or potash, or in glue. Plaster of Paris is the material most commonly employed, for it is cheap and easily obtained and prepared. The most convenient method of using it is to make roller bandages of some thin, open-meshed material, such as cross-barred muslin or crinoline, and rub the dry plaster well into them before rolling them up. When required for use the roller is thoroughly wet by placing it in a basin of water, gently squeezed, and then rapidly applied to the limb, while the successive turns are rubbed smooth with the wet hand. Before the plaster is applied the limb should be covered with a thin layer of raw cotton, or with a few turns of an ordinary bandage. If crinoline cannot be obtained ordinary bandages must be unrolled, drawn through a thin mixture of plaster, rolled up again, and rapidly applied before the plaster has had time to set.

FIG. 33.



Suspensory bandage.

Starch should be spread upon strips of coarse paper, which are then applied longitudinally to the limb; silicate of soda or potash, dextrine, and glue are employed by first rolling up the ordinary bandages in the solution, and then applying them in the usual manner, or the band may be applied dry and the mixture rubbed on each successive layer. The skin must be protected by a layer of cotton or a few turns of a dry bandage. The silicates and the glue dry quite rapidly, the starch and the dextrine much more slowly. The dextrine can only be dissolved by first mixing it with alcohol, and then adding hot water and stirring it until it is reduced to the proper consistency. Two, or at most three, layers of bandage are usually sufficient.

A convenient method of employing plaster in the form of splint without covering the limb entirely, is one in general use in the Paris hospitals. A strip of crinoline, folded in six or eight thicknesses of the proper length and breadth, is drawn through the liquid plaster, stripped down rapidly to remove the excess, applied to the limb, and fixed with a few turns of an ordinary roller bandage. Instead of a single strip two may be used and applied on opposite sides of the limb. Such a splint fits the limb accurately, and will not make undue pressure at any point.

Sayre's Plaster of Paris Jacket.[1]—In connection with this subject, and in view of the importance and recent origin of this method of treating spinal disease, it has been thought proper to add a description of the method of applying the Plaster of Paris jacket.

The bandages are made of strips of crinoline three yards long and from two and a half to three inches wide, according to the size of the patient, filled with dry plaster as before described, and put up in rolls which are moistened by setting them on end in a basin of water just before they are to be applied. For the purpose of strengthening the jacket and diminishing the amount of plaster required, narrow strips of tin, roughened on both sides like a nutmeg grater, are placed longitudinally around the body at intervals of two or three inches between the turns of the plaster bandage. The skin should be protected by an elastic, closely fitting undershirt of some soft woven or knitted material, without arms, but with tabs to tie over the shoulders.

As it is difficult for an assistant to hold the patient suspended during the application of the dressing, the apparatus shown in Fig. 34 has been devised. It consists of a curved iron cross-bar, to which are attached an adjustable head and chin collar and axillary bands. To a hook in the centre is attached a compound pulley, the other end of which is secured either to a hook in the ceiling or to the top of a tripod eight or ten feet high (Fig. 35).

The collar and bands having been carefully adjusted, the patient is drawn up until the feet swing clear of the floor, and a wedge-shaped pad of raw cotton folded in a handkerchief is placed over the abdomen between the shirt and the skin, its thin edge directed downward. This is intended to leave room, when removed, for the distention of the abdomen after meals. It is important to make the pad thin where it lies under the lower edge of the jacket, for otherwise the latter would fit too loosely.

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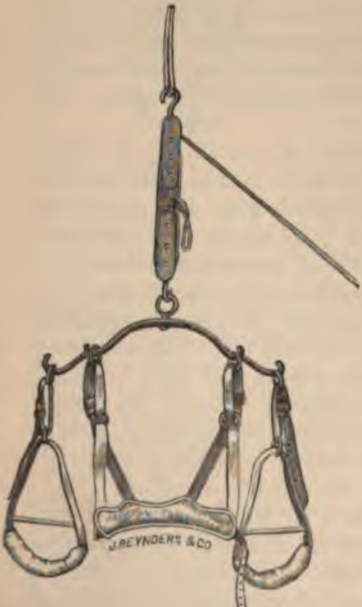
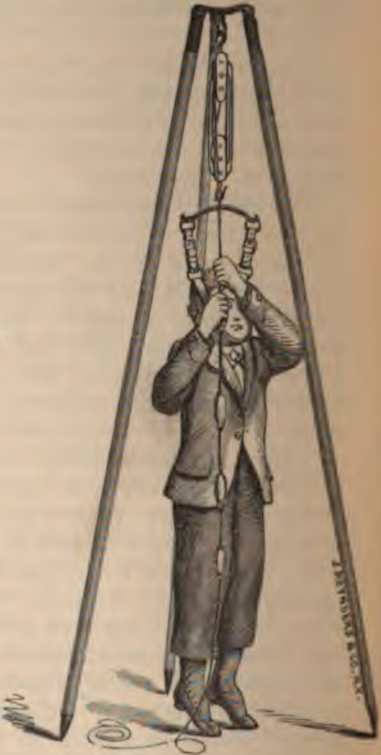
[1] Spinal Disease and Spinal Curvature, by Prof. L. A. Sayre, 1877.

Fig. 34.



Suspensory apparatus.

Fig. 35.


J. REYNDERS & CO. N.Y.

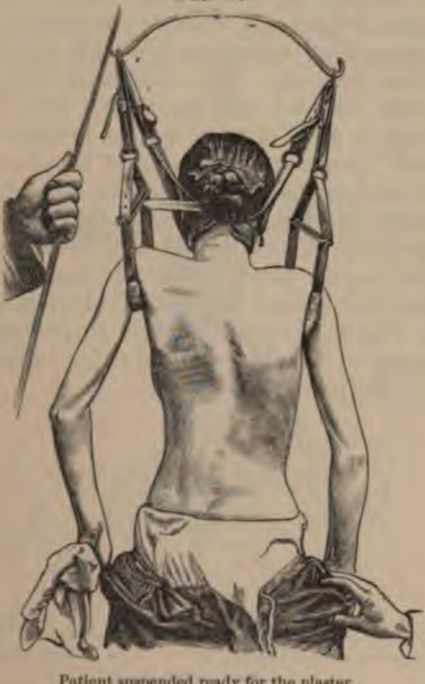
Tripod

If the skin covering any bony prominences has become irritated, it must be protected by small pads of raw cotton or cloth placed on either side; and it is well also to place pads of two or three thicknesses of cloth, three or four inches long, over each anterior iliac spine, removing them before the plaster has set.

If the patient is a female, and especially if she is just reaching the age of puberty, a pad of cotton in a handkerchief must be placed over each mamma, and withdrawn before the plaster has set.

The undershirt having been tied over the shoulders, pulled down, and kept stretched by means of tapes fastened to its lower edge in front and behind, and tied together tightly over a handkerchief placed on the perineum, the patient is slowly drawn up by means of the apparatus until he feels perfectly comfortable, *and never beyond that point*, and kept in this position (Fig. 36) until the bandage has been applied.

FIG. 36.



Patient suspended ready for the plaster.

The bandage is first carried around the smallest part of the body, then around and around downward, to and a little beyond the crest of the ilium, and afterward from below upward spirally until the entire trunk from the pelvis to the axilla has been encased. It must be applied smoothly and not drawn tight; it should be simply unrolled with one hand, while the other follows and brings it into smooth close contact with all the irregularities of the surface of the trunk. After one or two thicknesses of bandage have been thus applied, the strips of tin are laid on, and another layer placed over them. In a very short time the plaster sets with sufficient firmness to allow the patient to be removed from the suspending apparatus, and laid upon his face or back on a firm mattress. The abdominal, iliac, and breast pads are then removed, and the plaster gently pressed in with the hand in front of each spinous process of the ilium. If any weak spots appear they must be strengthened by wetting the surface and dusting on more plaster.

If abscesses or ulcers are present they must be covered with a large piece of oil-silk, and a hole cut in the undershirt at the proper point before the bandage is applied. Then, before the plaster has entirely hardened, a fenestra is cut with a knife, the oil-silk cut in strips from the centre of the opening to the edge, and the strips turned back and glued fast to the plaster with shellac.

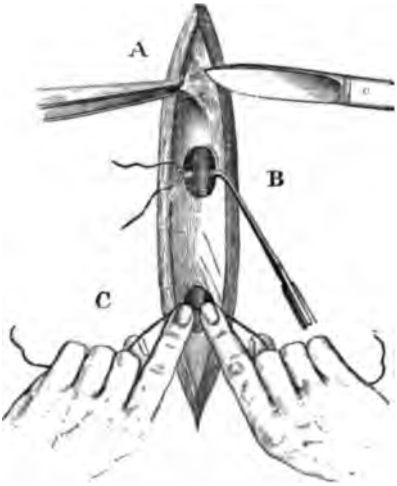
PART II.

LIGATURE OF THE ARTERIES.

GENERAL DIRECTIONS.

A POINT for the application of the ligature should be chosen, if possible, not nearer than half an inch to any collateral branch above or below it. The operator should make himself thoroughly familiar with the anatomical relations of the parts and the landmarks of the operation; he should proceed methodically, in accordance with a definite plan, and seek for and recognize each layer, each landmark in its order.

FIG. 37.

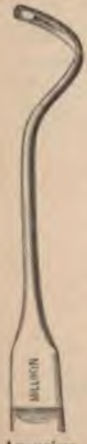


This diagram represents three distinct operations.
A. Opening the sheath. B. Drawing ligature round the artery.
C. Tying artery.

It is well to mark upon the skin with ink or iodine the line of the proposed incision; the incision should be free, and, so far as possible, its centre should correspond with the point at which the ligature is to be applied. The first incision should go fairly through the skin, and then be carried down to the enveloping fascia by repeated applications of the knife. The fascia should be pinched up, nicked, and divided upon a director if the vessels lie immediately below it, or upon the finger if a muscular interstice is to be sought for. The division of the fascia should equal in length the external incision.

The knife is then laid aside and the artery sought for by separating the tissues with the fingers or a director. The sheath is recognized by the communicated pulsation, and by the absence of the pinkish-white color and smooth shining surface which characterize the artery. When found, it is gently pinched up with the forceps, the flat of the knife laid upon it, and a hole one-quarter of an inch long carefully made in it. A distinct sheath is found only about the main trunks, and is replaced in the others by a layer of cellular tissue, which is more readily separated by tearing with the point of a director or with two forceps.

FIG. 38.



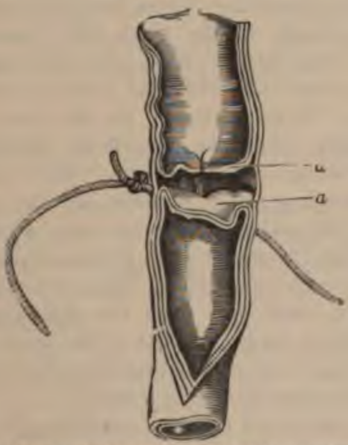
Aneurism needle.

When the pinkish-white coat of the vessel has been fairly exposed, each edge of the hole in the sheath is grasped in turn with forceps, and the sides of the vessel gently separated from the sheath by tearing through the slight attachments with the point of a director.

A threaded aneurism needle is then entered on that side where the parts lie that are most to be avoided, and passed behind the artery, care being taken not to raise the latter from its bed, until its eye appears upon the other side; the thread is then picked up with forceps and drawn through while the needle is withdrawn. The precaution should never be omitted of trying if compression of the vessel between the finger and the ligature arrests pulsation in its distal branches, for the best surgeons have mistaken a nerve or strip of fascia for the artery. The main trunks can be readily distinguished from the veins by their appearance—the veins resembling a leech, while the arteries are white and feel like a cord or band under the finger—and by their known anatomical relations; but it is often very difficult to recognize the smaller arteries, since they closely resemble the veins. The operator has to depend upon three indications: 1, the fact that when there are two satellite veins the artery is placed between them; 2, pulsation; 3, alternate compression of the vascular bundle at the two ends of the incision. Pressure at the proximal end causes the artery to shrink and the veins to swell; pressure at the distal end has the contrary effect.

The ligature is then tied with a square knot (Fig. 2), tightly enough to cut the inner coats of the vessel, and one or both ends cut short, according to the material used. If antiseptic catgut or silk is used, both ends may be cut short and the wound closed. The catgut is soon absorbed, and it has been proved that silk thus prepared is unirritating, and does not cause suppuration. The lymph thrown about these ligatures gives strength to the wall of the vessel and additional security against secondary hemorrhage. Primary

FIG. 39.



a, a. Inner coat of an artery ruptured by a ligature.

union, at least of the deep parts of the wound, may be confidently expected.

If unprepared silk is used, only one end of the ligature is cut short; the other is brought out through the wound, which then remains open until after the ligature has cut through the artery and been thrown off by suppuration.

While making the incisions the position of the parts should be such that the muscles which serve as guides shall be tense, but while seeking for the artery the muscles should be relaxed so as to give more room.

ANATOMY OF THE SUPRA-CLAVICULAR REGION.

The superficial fascia underlies the platysma, and incloses the sterno-cleido-mastoid in a reduplication of itself. The middle, or sterno-clavicular, fascia has a common origin with the superficial fascia in the linea alba between the two sterno-thyroid muscles, divides into three layers to form sheaths for the sterno-thyroid and sterno-hyoid, unites, and again divides to form a sheath for the omo-hyoid, unites again and finally joins the superficial fascia between the trapezius and sterno-cleido-mastoid. This middle fascia is strong and resisting, and incloses all the vessels of the region except the external jugular vein, which is subcutaneous throughout its course until it turns inward to join the subclavian above the clavicle. These two fasciæ are separated from each other and from the skin by loose cellular tissue, in which a large amount of fat may be deposited, and it is of prime importance therefore that they should be recognized in the search for the vessels.

The vessels which are approached through this region are the innominate, the subclavian, and the common carotid. The bifurcation of the innominate corresponds with the sterno-clavicular articulation, and in old people, as well as in exceptional cases, rises from five to ten millimetres above it. It lies in front and on the right side of the trachea, and is crossed anteriorly by the left innominate vein. At the bifurcation the subclavian lies behind and to the outer side of the carotid, and is crossed by the pneumogastric and phrenic nerves close to its origin, the former giving off the recurrent laryngeal which turns under the artery and rises again behind it. The carotid, which at first lies behind the sterno-cleido-mastoid, soon reaches its anterior edge, and at the same time increases its distance from the trachea. While the internal jugular lies wholly within the middle cervical fascia, the subclavian vein is enveloped by a reduplication of it and held closely against the clavicle thereby. It is therefore more superficial, and on a lower plane than the curved portion of the subclavian artery, and need not be uncovered in the search for the latter. The branches of the subclavian, seven in number, arise (with one exception, the transversalis colli) from its first portion, that comprised between its origin and the inner border of the scalenus anticus. The transversalis colli may arise from the first part, or the second (between the scaleni), or even the third (beyond the scaleni). The supra-scapular crosses in front of the scalenus anticus and runs downward and outward to the clavicle, lying below the line of the incision made in tying the subclavian in its third portion.

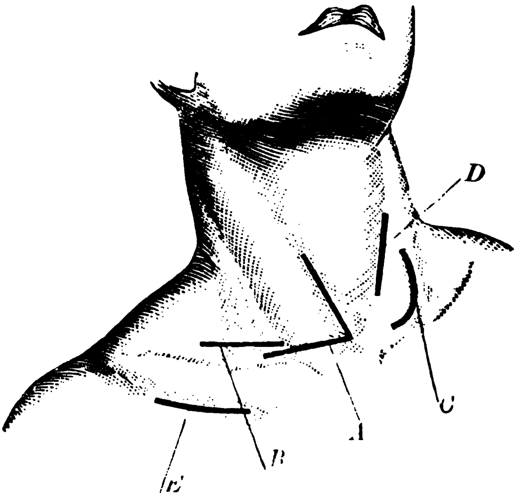
LIGATURE OF THE INNOMINATE ARTERY.

Anatomy.—The artery is in relation in front with the innominate veins and the pneumogastric nerve; on the inner side with the trachea; on the outer side and behind with the pleura. It lies immediately behind the sterno-clavicular articulation.

Five different incisions have been proposed. A vertical one in the middle of the neck (King); a horizontal one 4½ inches long, beginning in the middle line and passing outward parallel to and half an inch above the clavicle (Manec); an oblique one in the interval between the sternal and clavicular attachments of the sterno-cleido-mastoid (Sédillot); an oblique one from the anterior border of the left sterno-cleido-mastoid 2½ inches above the clavicle down to and a little beyond the left sterno-clavicular articulation (Velpeau); a V-shaped one, of which one side lies over the anterior edge of the sterno-cleido-mastoid, and the other is parallel to and a little above the clavicle (Mott). The single incisions do not give sufficient room, and although they are more brilliant they should give way to the more pruden and practical one proposed by Mott.

Operation.—An incision 3½ inches in length is carrie along the anterior edge of the right sterno-cleido-mastoi ending half an inch above the sternum (Fig. 40). Anothe of the same length, is carried outward from the lower en of the first, half an inch above and parallel to the righ clavicle. These incisions are carried down to the superfici fascia, and the triangular flap between them dissected u

FIG. 40.



Ligature of arteries. *A.* Innominate. *B.* 2d or 3d portion of subclavian. *C.* 2d or 3 portion of subclavian (Skey) *D.* Vertebral or inferior thyroid. *E.* Axillary below th clavicle.

If the anterior jugular is encountered it must be draw downward. The sternal and part of the clavicular attach ments of the sterno-cleido-mastoid are now divided half a inch above the bone on a directer or with forceps and knife and the muscle drawn upward and outward, uncovering th sterno-thyroid and sterno-hyoid and the middle cervical fascia which here is very dense and covered by the inferio thyroid veins. The outer fibres of the sterno-hyoid and sterno-thyroid are now divided, the thyroid veins drawn aside, and the underlying or middle fascia torn through with the director, or opened very carefully with the knife. The common carotid is now seen at the bottom of the wound and traced downward to the innominate. The internal jugular is carefully pressed outward with a retractor; the left forefinger, passed into the wound between the artery and the innominate veins, presses the latter against the sternum, and the operator proceeds carefully to clean the artery with a director half an inch below its bifurcation. The needle, guided by the finger, is passed from the outer side so as to avoid the vein, nerve, and pleura.

The innominate has been tied only for aneurism of itself, of the subclavian, or of the primitive carotid. With one exception, the case of Dr. Smyth, of New Orleans, the operation has terminated fatally in every case; and, as it has been shown[1] that the treatment of aneurism by distal ligature yields satisfactory results, this operation is seldom justifiable. It may be rendered necessary by hemorrhage from the subclavian or carotid, but the attempt should always be made to tie the injured vessel in the wound before resorting to so dangerous a method as ligature of the innominata.

LIGATURE OF THE SUBCLAVIAN ARTERY.

The anatomical difference between the right and left subclavian is confined to the first portion of the artery, which in the left is much longer, more vertical in its direction, and situated more posteriorly even than the innominate; a separate description therefore is required only for the first portion.

1*st Portion. Left Subclavian.*—This operation, attempted unsuccessfully by Astley Cooper about 1820, has been generally deemed unjustifiable on account of the supposed impossibility of avoiding the thoracic duct and the pleura. It was, however, tied successfully by Dr. J. Kearny Rodgers, of New York, in 1845, the patient dying on the fifteenth day from hemorrhage; and recently McGill,[2] of Leeds,

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[1] Prof. W. H. Van Buren, On Aneurism. Paper read before the International Medical Congress, Philadelphia, 1876.

[2] Med.-Chir. Trans., vol. 58, p. 338.

England, laid bare the artery after a tedious and difficult dissection and applied metallic compression just below the origin of the vertebral artery for eight hours. The aneurism was quite filled by a firm coagulum, but unfortunately the pleura had been perforated during the operation, and the patient died of pleurisy on the sixth day. Dr. Rodgers's case shows that the artery can be tied without injury to the pleura or thoracic duct, and Mr. McGill's shows that its temporary occlusion is sufficient to consolidate the aneurism. In Mr. McGill's case the artery seemed to be abnormally placed, and was found with much difficulty at a depth of about three inches. Under more favorable circumstances the artery might be exposed as successfully as was done by Dr. Rodgers, and metallic compression or a temporary ligature, not drawn tightly enough to injure the inner coats of the vessel, might cause consolidation of the aneurism without exposure to the danger of secondary hemorrhage.

Operation.—A V-shaped incision similar to that described for ligature of the innominata (Fig. 40) is made upon the left side, and carried through the sterno-cleido-mastoid and outer fibres of the sterno-thyroid and sterno-hyoid muscles and the middle cervical fascia as before described. The carotid is then recognized, and, together with the internal jugular, drawn outward with a blunt hook. The muscles are now relaxed by bending the head and neck forward, and the cellular tissue torn through with forceps and director. The knife should no longer be used, on account of the risk of injury to the thoracic duct, which is embedded in the loose tissue between the vessels and the vertebræ, and is rendered very difficult of recognition by its small size and thin walls. It runs directly across the route to the artery while passing from the bodies of the vertebræ to the anterior border of the scalenus anticus, and can be best avoided by making the search below and to the outer side of it in the lower angle of the wound.

The finger, passed downward and backward behind the carotid, soon feels the artery by pressing it against the side of the spinal column, the loose cellular tissue surrounding it is easily separated with the director, the vessel cleaned, and the needle passed from the inner side. The needle should have a short curve, and its point should be kept close against the vessel so as to avoid injuring the pleura.

1*st Portion. Right Subclavian.*—The first portion of the right subclavian has been tied unsuccessfully by Colles, Mott, and Liston. It is exposed in the same manner as the innominate artery, and the ligature passed from the outer side, the pneumogastric and phrenic nerves being pressed inward toward the carotid. The great danger of this operation lies in the proximity of collateral branches.

2*d Portion.*—This operation, first proposed and performed by Dupuytren, is rendered dangerous by the fact that one, and sometimes several large branches are given off from this part of the artery. The preliminary steps are the same as those employed in ligature of the 3d portion; after the middle cervical fascia has been divided, the tubercle of the first rib and the external border of the scalenus anticus are sought, the muscle bared and divided upon a director, the phrenic nerve which lies upon its anterior aspect being carefully avoided. As soon as the muscular fibres are cut they retract and leave the artery in full view.

3*d Portion. Anatomy.*—The 3d portion of the subclavian lies between the outer border of the scalenus anticus and the tubercle of the first rib in front and the brachial plexus behind, and below the posterior belly of the omohyoid; it is crossed on a much more superficial plane by the external jugular, which enters the subclavian near the middle of the clavicle. In muscular subjects the clavicular insertions of the trapezius and sterno-cleido-mastoid muscles lie near to, or may even join, one another; in others, they are from two to three inches apart. Ordinarily the vessel lies at a depth of one or one and a half inches below the surface, but in very fat persons, or when the clavicle has been pushed upward by an axillary aneurism, this distance may be increased to three inches.

Operation.—Beginning an inch outside of the sterno-clavicular articulation, make an incision three or four inches long parallel to and half an inch above the clavicle (Fig. 40, *B*). Divide the skin and the platysma; when the external jugular is exposed draw it to the inner side or divide it between two ligatures. Divide on a director the superficial fascia, and the clavicular portion of the mastoid muscle if necessary, and seek the posterior belly of the omo-hyoid. Draw this muscle outward and upward, and feel for the tubercle of the first rib, following down the outer border of the scalenus anticus. Depress the shoulder as much as possible, denude the artery with the finger-nail or the point of a director, and pass the needle from below, taking care not to include the lowest bundle of the brachial plexus in the ligature. In order to avoid mistaking this bundle for the artery, the tubercle of the first rib should always be found; the artery lies against it, between it and the nerve.

Skey prefers, in difficult cases, a curved incision "commenced about two and a half or three inches above the clavicle, upon, or immediately on the outer edge of, the mastoid muscle. This incision is carried slightly outward and downward, toward the acromion, and then curved inward along the clavicular origin of the mastoid muscle." (Fig. 40, *C*.) Ordinarily the external jugular is left to the outer side of the incision.

LIGATURE OF THE INFERIOR THYROID.

Anatomy.—After passing vertically upward, the artery curves inward to reach the under surface of the thyroid gland. The highest point of its curve is half an inch below the prominence on the transverse process of the sixth cervical vertebra, named by Chassaignaç the ***carotid tubercle.*** In old people it is somewhat higher. It lies behind the common carotid and internal jugular, and is separated from them by more or less dense cellular tissue. The guides to the vessel are the carotid and Chassaignac's tubercle.

Operation.—Make an incision three and a half or four inches in length along the anterior border of the sterno-cleido-mastoid, ending an inch above the clavicle (Fig. 40, *D*). Lay bare the border of the muscle, and draw it outward, tear through or divide the middle fascia and draw the carotid and internal jugular outward with a retractor. Flex the head slightly to relax the parts, feel with the finger for the carotid tubercle, and seek the artery below it, separating the cellular tissue with a director. Pass the needle between the artery and vein.

LIGATURE OF THE VERTEBRAL ARTERY.

Anatomy.—The vertebral artery passes from the first portion of the subclavian upward and backward to the transverse process of the sixth cervical vertebra. It is accompanied by a vein which lies in front, and is covered by the deep cervical fascia. The guide to it is the carotid tubercle.

Operation.—The first incision is the same as for ligature of the inferior thyroid (Fig. 40, *D*). The anterior edge of the sterno-cleido-mastoid is exposed and drawn outward. The middle fascia is divided, and the carotid and jugular drawn inward. The gap between the longus colli and the scalenus anticus is then felt for about half an inch below the carotid tubercle, the deep fascia covering it torn through, the muscles separated, the vertebral vein pushed aside, and the artery exposed.

Chassaignac prefers an incision along the posterior border of the mastoid muscle, and reaches the carotid tubercle by drawing the muscle and vessels inward. If the muscle is very broad some of its clavicular fibres must be divided.

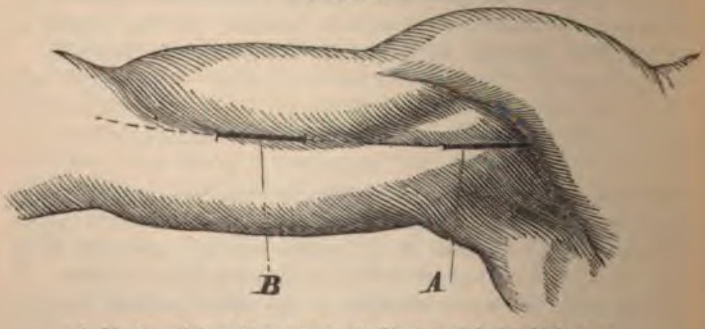
LIGATURE OF THE AXILLARY ARTERY.

Anatomy.—The axillary extends from the middle of the clavicle to the lower edge of the tendon of the teres major. The axillary vein lies on the inner side and in front of it. and the brachial nerves invest its lower portion closely. It can be tied below the clavicle in the clavi-pectoral triangle formed by the clavicle, inner border of the pectoralis minor, and the thorax, or in the axilla. The strong fascia which unites the coracoid process and clavicle, and forms the suspensory ligament of the axilla, the costo-coracoid fascia, sends a prolongation about the upper portion of the axillary vein which keeps its walls from sinking in; the cephalic vein ascending in the groove between the deltoid and pectoralis major perforates this fascia and joins the axillary vein at the inner border of the tendon of the pectoralis minor, close by the origin of the acromial thoracic artery.

A. *Ligature under the Clavicle.*—(Fig. 40, *E*.) Make an incision extending from the summit of the coracoid process four or four and a half inches along the lower border of the clavicle. Divide successively the skin, subcutaneous tissue, superficial fascia, and pectoralis major, and then tear carefully through the costo-coracoid fascia, avoiding injury to the cephalic vein at the outer part of the wound. The pectoralis minor is now exposed, and after separating the cellular tissue with the point of a director the axillary vein is seen crossing from the upper edge of the muscle to the clavicle. The artery is completely hidden by it, lying on the outer side and a little behind. The vein must now be drawn inward, the needle entered between it and the artery, and the ligature applied as near as possible to the clavicle on account of the proximity of the acromial thoracic branch.

B. *Ligature in the Axilla. Anatomy.*—The tissues and organs on the outer side of the axilla are arranged in the

FIG. 41.



A Ligature of the axillary artery. *B*. Ligature of the brachial artery.

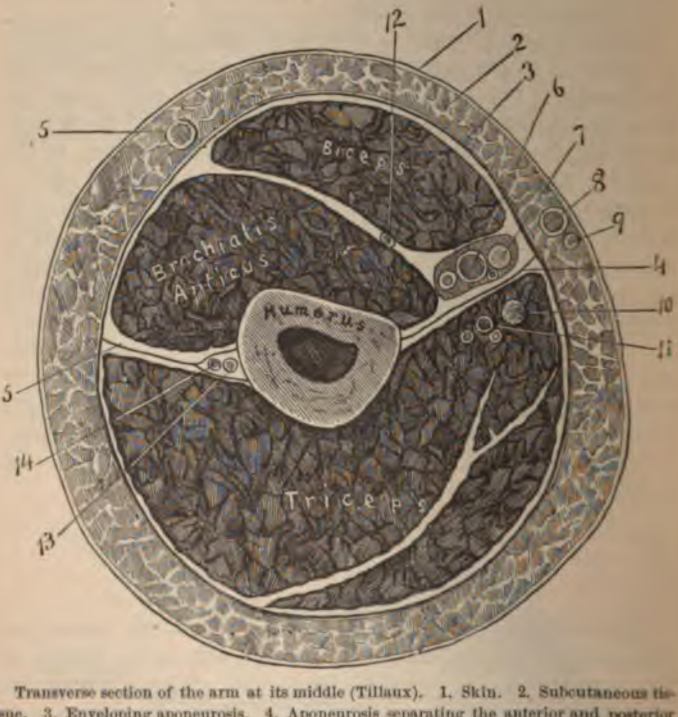
following order: 1, the skin; 2, the subcutaneous cellular tissue; 3, the fascia; 4, the axillary vein; 5, the internal cutaneous and ulnar nerves; 6, the axillary artery; 7, the median nerve; 8, the coraco-brachialis; 9, the humerus and articular capsule. The old rule for exposing the artery here was to make a longitudinal incision at the junction of the anterior and middle thirds of the axilla, find the vein, count two nerves, and look for the artery just beyond the last one. This is a difficult and dangerous method, and a much simpler one has been substituted by Malgaigne, who was the first to point out that the coraco-brachialis muscle is the real guide to the artery.

Operation.—The arm is abducted completely, the incision commenced at the inner border of the coraco-brachialis over the head of the humerus and carried two and a half or three inches down the arm parallel to the course of the artery. It should involve the skin only, so as to avoid injury to the basilic vein. If the edge of the coraco-brachialis cannot be distinguished, the incision should be made according to the old rule, at the junction of the inner and middle thirds of the axilla. The aponeurosis is now divided upon a director over the coraco-brachialis, and the fibres of the inner border of this muscle exposed. The parts are then relaxed by bringing the arm nearer the trunk, and the posterior side of the wound, including the vein, ulnar and internal cutaneous nerves, is drawn back with a retractor; and the artery, overlain by the median nerve, usually appears at the bottom, covered perhaps by the posterior part of the sheath of the coraco-brachialis.

LIGATURE OF THE BRACHIAL ARTERY.

Anatomy.—The brachial artery runs from the junction of the anterior and middle thirds of the axilla to the middle of the anterior aspect of the elbow. It occupies, when the forearm is supinated, the groove between the biceps and triceps, being partly covered by the former in muscular subjects, and separated from the bone by the inner edge of the coraco-brachialis, and of the brachialis anticus. It lies in the anterior loge of the arm, which is bounded posteriorly on this side by a prolongation of the enveloping aponeurosis, extending down to the bone between the biceps in front and the triceps behind. It lies, consequently, within the sheath of the biceps, and the inner edge of this muscle is the sure guide to it. It lies between two satellite veins, which anastomose frequently, and has the median nerve in immediate relation with it on the side next the skin. The basilic vein directly overlies it between the skin and the aponeurosis. The artery presents frequent anomalies. The most common is its premature bifurcation into the radial and ulnar, which may take place as high as in the axilla, in which case one of the branches is superficial, perhaps even subcutaneous, while the other follows the usual

FIG 42.

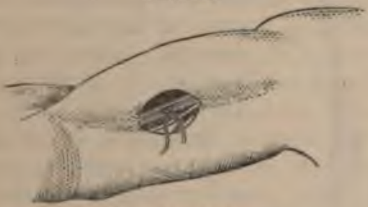


Transverse section of the arm at its middle (Tillaux). 1. Skin. 2. Subcutaneous tissue. 3. Enveloping aponeurosis. 4. Aponeurosis separating the anterior and posterior loges on the inner side. 5. Division on the outer side. 6. Brachial artery and veins. 7. Median nerve. 8. Basilic vein. 9. Internal cutaneous nerve 10. Ulnar nerve. 11. Its artery and veins. 12. Muscular cutaneous nerve. 13. Muscular spiral nerve. 14. Superior profunda artery. 15. Cephalic vein.

course. The median nerve occupies the same sheath with the artery, lying first on the outer side and then crossing, in front or behind, very obliquely to the inner. The ulnar nerve, accompanied by an artery and two veins, lies in the substance of the triceps immediately behind the brachial artery and median nerve, separated from them only by the above-mentioned prolongation of the enveloping aponeurosis, and as they form a group differing from the other only in size, the artery may be mistaken for the brachial if met with (Fig. 42). This error will not be made if the fibres of the biceps alone are exposed, and the incision confined to the anterior loge.

Operation.—Arm abducted, forearm supinated. Make an incision three inches long in the middle third of the arm, along the inner border of the biceps through the skin and subcutaneous cellular tissue, taking care not to injure the basilic vein, which should be kept posterior tö the incision. Divide the aponeurosis and expose the fibres of the biceps. If the muscle is large draw it forward, and the sheath inclosing the artery, nerve, and veins will be disclosed. This is torn through carefully with a director, the median nerve separated and pushed aside, thê artery separated from its veins, and the ligature passed from the side of the nerve.

FIG. 43.



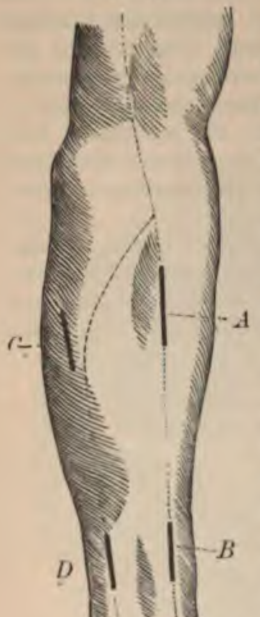
Ligature of brachial artery.

LIGATURE OF THE RADIAL ARTERY.

Anatomy.—The radial artery extends in a straight line from a point half an inch below the centre of the fold of the elbow to the ulnar side of the styloid process of the radius;

it occupies the groove bounded on one side by the supinator longus, on the other by the pronator radii teres and flexor carpi radialis. It is covered only by the skin, cellular tissue, and aponeurosis; but in muscular subjects the muscular interstice in which it lies may be very deep. It is accompanied by two veins, and by no nerve. It occupies in its upper third the sheath of the pronator, and consequently the fibres of the supinator longus should not be exposed in the search for the artery, although the edge of the muscle may be taken as a guide to it. The radial nerve lies within the sheath of the supinator longus, and at first comes quite close to the artery; it then passes behind and to the outer side of the tendon of the muscle. It should not be seen during the operation.

FIG. 44.



Ligature of the radial and ulnar arteries.

Operation. In the upper third.—Make an incision two and one-half inches long in the line above mentioned, beginning one and one-half inches below the fold of the elbow. Avoiding the superficial veins, carry the incision through the cellular tissue. Recognize the edge of the supinator longus, and divide the aponeurosis along the ulnar side of it, exposing the fibres of the pronator. Press apart the two muscles if necessary, separate the artery from its veins, and pass the ligature.

In the lower third (Fig. 44).—Make an incision in the above-mentioned line, if the position of the artery cannot be made out by its pulsations, two inches long, ending an inch above the wrist. Divide the skin and cellular tissue, and then the fascia carefully upon a director. Separate the artery from the two veins, and pass the ligature.

LIGATURE OF THE ULNAR ARTERY.

Anatomy.—In its first third the ulnar artery passes obliquely underneath the superficial layer of muscles, including the superficial flexor of the fingers, to the inner side of the arm, where it becomes superficial, and lies between the flexor carpi ulnaris on the inside and the flexor sublimis digitorum on the outside. It then descends to the wrist in the direction of a line uniting the internal condyle of the humerus with the outer border of the pisiform bone. It is accompanied by two veins, and is joined by the ulnar nerve just before it becomes superficial, the nerve lying upon the inner or ulnar side of the artery. It may be tied at any point in the middle and lower thirds. As the deep and superficial flexors of the fingers are separated by a fascia, and as the artery lies below this fascia, it is covered in the lower part of its course by two distinct fasciæ, the enveloping fascia of the limb and this second one which unites the tendon of the flexor carpi ulnaris with those of the flexors.

Operation. At the junction of the upper and middle thirds.—Beginning four finger-breadths below the internal condyle of the humerus make an incision three and one-half or four inches long in the line above mentioned (Fig. 44). Expose the enveloping fascia clearly, and, drawing back the posterior lip of the wound, seek the first muscular interstice in front of the ulna. It is that between the flexor carpi ulnaris and the flexor sublimis digitorum, and can be recognized by the finger as a slight depression, or by the eye as a white line under the fascia. Divide the aponeurosis, beginning at the lower angle where the space between the muscles is broadest, and then, instead of following the interstice directly backward, raise the flexor sublimis and advance transversely across the arm in the search for the artery which lies upon the deep flexor. Isolate the artery, and pass the needle from the side of the nerve.

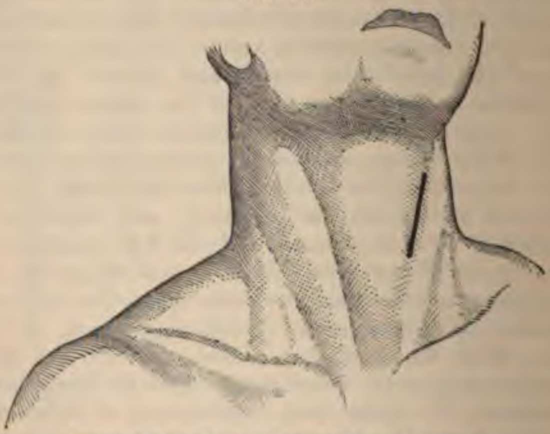
In the lower third (Fig. 44).—Make an incision slightly to the radial side of the tendon of the flexor carpi ulnaris, or in the line before mentioned, two inches long, and ending an inch above the end of the ulna. Divide the enveloping fascia upon a director, and tear through the second over the vessel, which can be seen and felt through it. Isolate the artery, and pass the needle from within outward so as to avoid the nerve.

LIGATURE OF THE COMMON CAROTID.

The place of election for ligature of the common carotid is just above the omo-hyoid muscle, but the lesion which renders the ligature necessary may require it to be applied at a much lower point. The vessel has been tied successfully at a point one-eighth of an inch from its origin at the bifurcation of the innominata.

The steps necessary to place a ligature upon the common carotid in the first part of its course are the same as for ligature of the first portion of the subclavian or of the innominata (*q. v.*). After the vessel has been exposed, the internal jugular is pressed to the outer side, the artery denuded, and the needle passed from the side of the vein.

FIG. 45.



Ligature of the common carotid at the place of election.

At the Place of Election.—The bifurcation of the common carotid is on a line with the upper border of the thyroid cartilage. The place of election for tying it is about three-quarters of an inch below its bifurcation. The guide to the artery is the anterior border of the sterno-cleido-mastoid muscle, and the danger is of wounding the jugular vein, which, when full, entirely covers the artery on the outer side.

Operation.—Make along the anterior border of the sterno-cleido-mastoid an incision three inches in length, the centre of which corresponds with the crico-thyroid space (Fig. 45). Divide the skin, platysma, cellular tissue, and aponeurosis, and seek for the interstice between the sterno-cleido-mastoid and the sub-hyoid muscles. When found, the latter must be pressed inward, and the artery will appear at the edge of the sterno-cleido-mastoid, the vein, which is external to it, remaining covered. The artery is bared with a director, and the needle passed from without inward.

If, instead of pressing the trachea and its muscles inward, the mastoid is drawn outward, the vein is exposed, almost completely overlying the artery, and, by its presence and the necessity of handling it, increases the difficulty and danger of the operation.

LIGATURE OF THE EXTERNAL CAROTID.

The free anastomoses which exist within the cranium between the two internal carotids render ligature of the common carotid insufficient to arrest hemorrhage from the external carotid; the ligature must be applied to the vessel itself, despite the number of its branches and the difficulty of recognizing them at the bottom of the incision. The operation is a difficult one, for there are many important organs to be avoided, and there is no direct guide to the vessel.

Anatomy.—The common carotid divides opposite the upper border of the thyroid cartilage (a little lower in females) into the external and internal carotids, which occupy nearly the same antero-posterior plane, the former being in front. At about three-quarters of an inch above the bifurcation the arteries cross, the external becoming posterior, the internal anterior. The internal carotid gives off no branches outside the cranium, while the external gives off eight. Of these the superior thyroid arises at or very near the bifurcation, the lingual, fascial, ascending pharyngeal, and occipital near the point where the artery passes under the digastric, about an inch above the bifurcation, the others at a considerable distance above. The hypoglossal nerve looping around the occipital artery at its origin crosses the external carotid to the hyoid bone, sending a branch, the *descendens noni*, down the outside of the artery.

There are thus three means of distinguishing the external carotid: 1, its branches; 2, its position with reference to the internal carotid; 3, its immediate relations with the hypoglossal nerve, the internal carotid occupying a deeper plane. In a search for the external carotid the operator may be satisfied with either of these guides, accordingly as one or the other presents itself. Should the nerve be first encountered, he will tie the vessel upon which it lies; should both vessels lie at the bottom of the incision, he will know that the anterior one is the external carotid; and if the vessel which he isolates has a branch, he knows it cannot be the internal carotid.

Although the force of the objection has been greatly diminished by the employment of antiseptic silk or catgut ligatures, which admit of primary union throughout the wound, it is still desirable that the ligature should be applied at a distance from branches of considerable size; and from this point of view the first half inch of the artery and the portion underlying the digastric are the places of election, and of these two the former alone is practicable. The connective tissue surrounding the two arteries at their origin is, however, unusually compact, rendering their denudation so difficult that any search for branches would be dangerous to the nutrition of the vessel's wall.

M. Guyon[1] has shown that, while the lingual and superior thyroid arteries vary greatly in their points of origin, the average distance between them is from 12 to 18 millimetres, or over half an inch; he calls the portion of the vessel between them the "trunk of the external carotid," and suggests that the ligature should be applied 6 mm. below the point at which the hypoglossal nerve crosses the artery, this nerve being, in the great majority of cases, in immediate relation with the origin of the lingual artery. Dolbeau, in his report upon this paper, advises that the superior thyroid should also be tied, and that the carotid should be sought for from below upward instead of from above downward, on account of the greater depth of its upper portion and the superposition of large veins. M. Guyon collected 24 cases of ligature of the external carotid without especial reference to the proximity of branches, and in only one of them did secondary hemorrhage occur.

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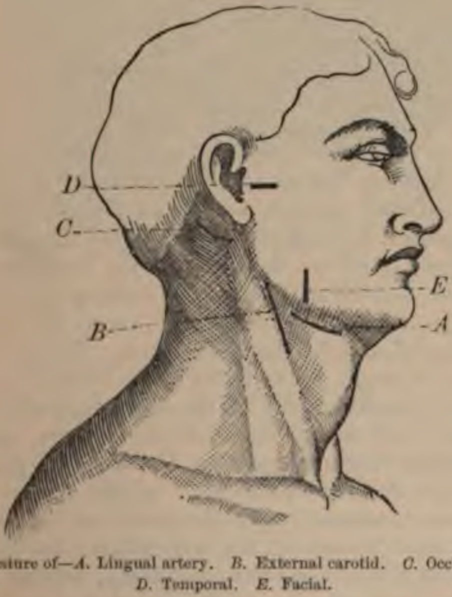
[1] Mémoires de la Soc. de Chirurgie, 1864, p. 555.

Operation.—When the head is extended and the face turned to the opposite side, an incision carried from the angle of the jaw to the anterior border of the sterno-cleido-mastoid opposite the top of the thyroid cartilage will cross the artery obliquely (Fig. 46, *B*). It must be carried through the skin, platysma, and subcutaneous cellular tissue,

FIG. 46.



Ligature of—*A*. Lingual artery. *B*. External carotid. *C*. Occipital. *D*. Temporal. *E*. Facial.

the external jugular being drawn aside when encountered. The superficial fascia is then divided in the line of the incision, care being taken not to deviate to the right or left. and the deeper and denser layer then torn through with the director. When the artery has been exposed and cleaned. the needle is passed from behind forward.

The lymphatic glands of the region are numerous and often large, and may be mistaken for the artery. There is no objection to removing any that may interfere with the search for the vessel.

LIGATURE OF THE INTERNAL CAROTID.

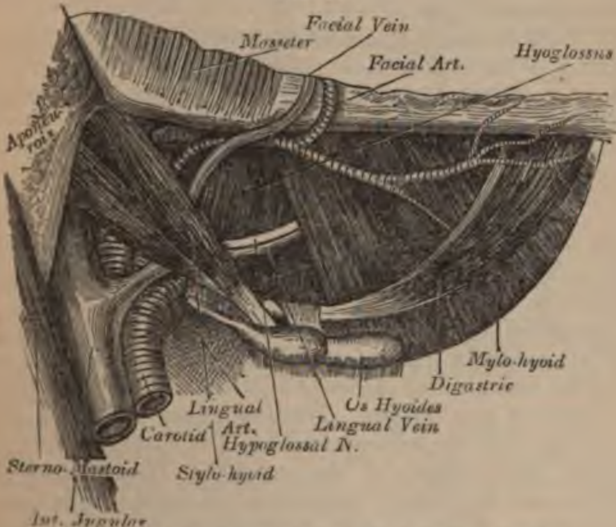
This is to be done according to the method described for the external carotid.

LIGATURE OF THE LINGUAL ARTERY.

Anatomy.—The lingual artery arises from the external carotid, on a level with the great horn of the hyoid bone. and passes between the middle constrictor of the pharynx and the hyoglossus upward and forward. It is occasionally accompanied by a small vein, but the lingual vein is separated from it by the thickness of the hyoglossus muscle. Its one important branch, the sublingual, sometimes has its origin at or near the point where the lingual is usually tied, and may be mistaken for it. The artery may be tied near its origin, between the great horn of the hyoid bone and the posterior belly of the digastric, but its depth at this point, and the presence of large veins, make the operation difficult and dangerous. The place of election is in the triangle bounded posteriorly by the posterior belly of the digastric, anteriorly by the posterior border of the mylo-hyoid, and above by the hypoglossal nerve. It is covered at this point by the skin, platysma, cervical aponeurosis, submaxillary gland, and the hyoglossus muscle, the fibres of which form the floor of the triangle just described.

Operation.—Make a curved incision two inches long, its concavity directed upward, its centre one-quarter of an inch above the hyoid bone at a point midway between the median line and the extremity of the great horn (Fig. 46, *A*). Divide the skin and platysma, pushing the superficial veins aside, and then the cervical aponeurosis, which may be very thin. Raise the submaxillary gland, find the posterior belly of the digastric, its attachment to the hyoid bone, the posterior border of the mylo-hyoid, and the hypoglossal nerve accompanied by the lingual vein. Draw the hyoid bone slightly downward with a blunt hook fixed in the lower angle of the triangle bounded by these organs, and then, pinching up the fibres of the hyoglossus with a pair of forceps, divide them carefully along a line parallel to the nerve, and midway between it and the bone. As the cut fibres retract, the artery is disclosed below them; separate it from its vein, if there be one, and pass the ligature.

FIG. 47.



Anatomical relations of the lingual and facial arteries. (Tillaux.)

LIGATURE OF THE FACIAL ARTERY.

The facial artery crosses the inferior maxilla just in front of the anterior edge of the masseter, from which it is separated by the facial vein (Fig. 47). A depression, in which it is lodged, can usually be felt on the lower edge of the bone. The artery can be exposed by a vertical incision along its course, or by a horizontal one along the lower border of the maxilla.

Operation (Fig. 46, *E*).—Beginning at the lower edge of the maxilla make an incision one inch in length along the course of the artery; divide the skin, subcutaneous tissue, and fascia; separate the artery from the vein and pass the needle between them.

If the horizontal incision is used, it should extend three-quarters of an inch on each side of the artery, the anterior edge of the masseter should be recognized, and the vessel sought for immediately in front of it.

LIGATURE OF THE OCCIPITAL ARTERY.

At the Mastoid Process.—The guides to the vessel are the apex and posterior border of the mastoid process, the digastric groove on its inner surface, and the digastric muscle.

Operation (Fig. 46, *C*).—Starting from a point half an inch below and in front of the apex of the mastoid process, carry the incision two inches obliquely backward parallel to the border of this process. Divide the skin and enveloping fascia, and then the sterno-mastoid and its insertion throughout the entire length of the incision. Then divide the splenius and its shining aponeurosis, and feel for the digastric groove. Pinch up and carefully divide a thin fascia which covers the anterior face of the splenius. Starting from the belly of the digastric, separate the cellular tissue in the anterior angle of the wound with a director, denude the artery and tie. (*Chauvel.*)

LIGATURE OF THE TEMPORAL ARTERY.

(Fig. 46, *D*.)—Make a transverse incision one inch long, extending from the tragus of the ear forward over the zygomatic arch. Separate the subcutaneous cellular tissue, which is very dense and fibrous, with a director, and seek the artery embedded in it about a quarter of an inch in front of the ear. Press the vein backward, pass the needle from behind forward, taking care not to include in the ligature the temporal branch of the auriculo-temporal nerve, which is sometimes in close relations with the artery.

LIGATURE OF THE ABDOMINAL AORTA.

This operation has been performed eight times, with a fatal result in each case. The patients survived for periods varying from a few hours to ten days. The artery may be reached through the abdominal cavity by an incision in the median line, or, without dividing the peritoneum, by an incision in the flank. The objection to the former is the danger consequent upon exposure of the peritoneal sac and its contents, but the steadily improving results of abdominal surgery show that this is not exceptionally great. On the other hand, the application of a ligature, even under the most favorable circumstances, after the artery has been exposed by the other method, requires the utmost dexterity, the chance of exciting peritonitis is great, and, finally, the presence of the aneurism and the displacements and adhesions it has caused may render it impossible to reach the vessel.

Operation. Through the Peritoneal Cavity.—An incision in the linea alba, extending from a point three inches above the umbilicus to one three inches below it, and curving to one side to avoid the umbilicus. Divide the peritoneum upon a director, press the intestines aside, tear through the peritoneum covering the aorta with the finger-nail, separate the nerves from its anterior surface, and pass the ligature from the outer side. Cut both ends short, and close the external wound as in ovariotomy.

LIGATURE OF THE COMMON ILIAC.

Anatomy of the Common, Internal, and External Iliac Arteries.—The aorta bifurcates usually on the left side of the fourth lumbar vertebra, and the direction of the common and external iliacs is represented by a line drawn from a point an inch above the umbilicus to another one-half an inch external to the centre of Poupart's ligament. The common iliac is usually two inches long, and bifurcates at the sacro-iliac synchondrosis, but it must be remembered that this bifurcation may take place at any point between one and a half and three or even four inches from the origin of the artery. The common iliac gives off no branches.

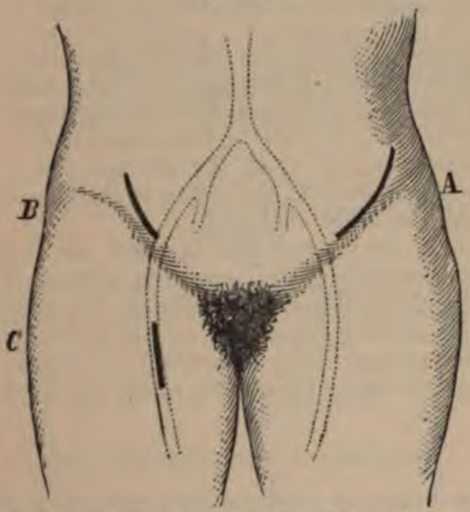
The external iliac runs downward and outward along the brim of the pelvis from the bifurcation to a point under Poupart's ligament midway between the anterior superior spine of the ilium and the symphysis pubis. Its two branches, the epigastric and circumflex ilii, are given off nearly opposite each other, a short distance above Poupart's ligament, sometimes much higher.

The internal iliac runs downward and backward into the pelvis for one and a half inches, dividing at the upper border of the great sacro-sciatic foramen into two large trunks. The ureter crosses the vessels at or just below the bifurcation of the common iliac, the vas deferens two and a half or three inches lower. Both are more closely adherent to the peritoneum than to the arteries. The iliac veins lie upon the inner side and posterior to the arteries; both pass behind the right common iliac, the right vein at its bifurcation, the left vein much higher up. The spermatic vessels and genito-crural nerve lie in front of the external iliac at the lower part of its course, and the circumflex iliac vein crosses it at the same place.

The abdominal wall at the point where the incisions are made is composed of the following layers in the order named: skin, subcutaneous cellular tissue, fascia, external oblique or its aponeurosis, internal oblique, transversalis, and transversalis fascia.

Operation.—Beginning at a point a finger's breadth above Poupart's ligament and just outside of the external iliac artery, make an incision four, five, or six inches in length, according to the thickness of the abdominal wall, parallel at first to Poupart's ligament, and curving upward after passing the anterior superior spine of the ilium (Fig. 48). Divide the skin, subcutaneous tissue, and fascia, exposing the aponeurosis of the external oblique; divide the latter upon a director throughout the whole extent of the incision, and then divide the fibres of the internal oblique and transversalis in the same manner, or by pinching them up with the forceps and cutting carefully with repeated slight touches of the knife, until the fascia transversalis, which varies much in density, is exposed. Raise the fascia at the lower angle of the wound, where it is most dense, with forceps, and make a hole in it large enough to admit the finger. Pass the forefinger through this hole, press back the peritoneum with it, and enlarge the hole upward in the line and to the full extent of the incision, the finger being kept between the peritoneum and the knife.

FIG. 48.



Ligature of: *A*, Common iliac; *B*, External iliac; *C*, Femoral in Scarpa's space.

The peritoneum is now raised from the psoas and iliacus muscles and drawn upward and inward by an assistant, while the operator seeks for the external iliac and passes the forefinger of his left hand along it to the common iliac, the thighs being flexed to relax the abdominal walls. As it is seldom that a good view of the artery can be obtained, the finger must be kept upon it, and the loose cellular tissue in which it is embedded very gently separated with the point of a director or the finger-nail. When the artery has been properly cleaned, pass the needle from within outwards.

The operation through the peritoneal cavity, as for ligature of the abdominal aorta, has recently been done with success, and will probably be preferred to the extra-peritoneal method.

LIGATURE OF THE INTERNAL ILIAC.

Its accompanying vein lies behind and on the inner side.

Operation.—Same as for ligature of the common iliac. After the peritoneum has been lifted up, the finger is passed along the external iliac to the bifurcation, and then downward for half an inch along the internal iliac. The vein being carefully protected, the artery is bared, and the ligature passed from within outward.

Ligature of the internal iliac has been seldom employed, except for traumatic gluteal aneurism, and in these cases, as Professor Van Buren[1] has pointed out, the treatment should be to cut down upon the sac, and tie both ends of the artery, hemorrhage being controlled by digital pressure made upon the internal iliac from within the rectum.

LIGATURE OF THE EXTERNAL ILIAC.

Various cutaneous incisions have been recommended for this operation. Sir Astley Cooper's extended from the external abdominal ring to within a short distance of the superior spine of the ilium; the objections to it are that it involves the division of the superficial epigastric, and, perhaps, of the internal epigastric also, and that the ligature can be applied only to the lower part of the artery. Abernethy's extended outward from the internal inguinal ring parallel to Poupart's ligament; by it the vessel is reached at a greater depth, but it has the great advantage of allowing extension, so that if it should prove necessary the ligature may be applied even to the common iliac. By curving the outer portion of the incision upward away from the superior spine of the ilium, the main branches of the circumflex ilii may be avoided.

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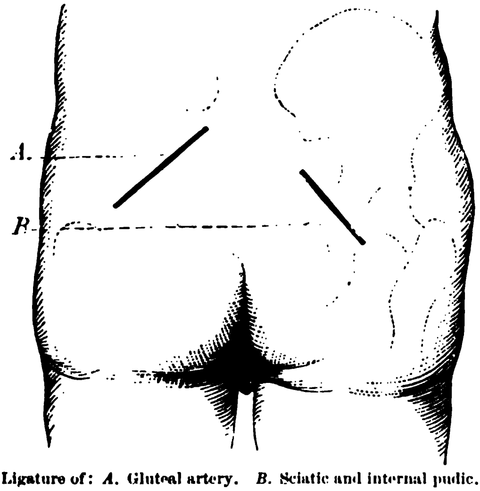
[1] Report on Aneurism; Proceedings of the International Medical Congress. 1876.

Operation.—Beginning over the outer side of the artery a finger's breadth above Poupart's ligament, make an incision three or four inches in length, at first parallel with Poupart's ligament, and then curving upward (Fig. 48). Carry this incision through the abdominal wall, and raise the peritoneum from the surface of the iliacus and psoas muscles in the same manner as for ligature of the common iliac. Flex the thighs so as to relax the abdominal muscles, and, while an assistant draws the peritoneum and the contained intestines upward and inward, seek the artery upon the inner border of the psoas. Clean it with a director or pair of forceps, and pass the needle from within outward.

LIGATURE OF THE GLUTEAL, SCIATIC, AND INTERNAL PUDIC ARTERIES.

The proper treatment of injury to either of these arteries is to enlarge the wound and tie both ends of the divided vessel, but it may happen that this would be impossible, and that ligature in continuity is required. The necessary in-

FIG. 49.



Ligature of: *A.* Gluteal artery. *B.* Sciatic and internal pudic.

cisions are those shown in Fig. 49. After division of the skin and fascia, the fibres of the gluteus maximus are separated, and held apart with long retractors, the deep fascia torn through, and the artery sought for.

The *gluteal artery* is to be sought for above the pyriformis muscle at the upper border of the great sacro-sciatic notch, where it can be felt near a small bony tubercle. It is covered by many large veins, which require very careful handling. The ligature should be applied as close to the notch as possible.

The *sciatic* and *internal pudic* arteries leave the great sciatic notch at the lower edge of the pyriformis; the former divides almost immediately, the latter reënters the pelvis through the lesser sacro-sciatic notch, lying on the inner side of the sciatic artery during its passage over the spine of the ischium.

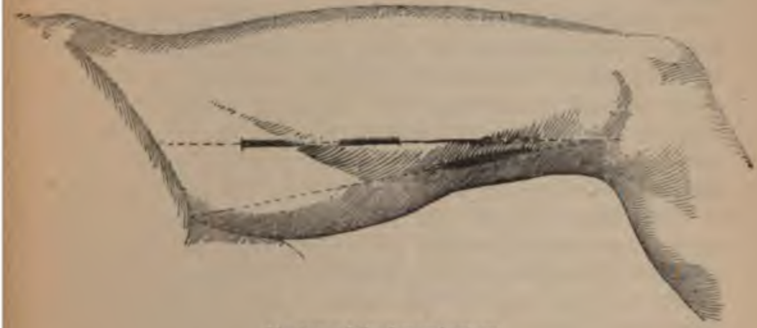
LIGATURE OF THE FEMORAL ARTERY.

Anatomy.—The femoral artery is the continuation of the external iliac, and extends in a straight line from a point midway between the anterior superior spine of the ilium, and the symphysis pubis to the ring in the tendon of the adductor magnus about four finger-breadths above the tubercle of insertion of that muscle on the upper portion of the inner condyle of the femur. In the first one or two inches of its course it gives off the superficial external pudic, epigastric, and circumflex ilii, and the much larger and more important profunda arteries. The anastomotica magna arises near its lower end. The artery is accompanied throughout by the femoral vein, which, at first, lies upon the inner side, and then becomes posterior. They are separated at first by a distinct septum, which disappears in the lower third. The anterior crural nerve emerges from below Poupart's ligament, about half an inch external to the artery; it divides up rapidly, and one of its branches, the internal or long saphenous, enters the sheath of the vessels three or four inches below the groin, and leaves it again after the artery has entered Hunter's canal; this name being given to the condensed sheath for a short distance above and below the point where it passes through the tendon of the adductor magnus. The artery passes under the sartorius at about the junction of its upper and middle thirds.

Ligature of the femoral above the origin of the profunda has proved unsatisfactory, and has been generally abandoned for that of the external iliac. The artery may be tied at any part of its course, but the point generally chosen is at the apex of Scarpa's triangle, next that in the middle of the thigh, and, lastly, in Hunter's canal.

Operation. A. *At the Apex of Scarpa's Triangle* (Figs. 48 and 50).—Make an incision three or four inches long, the centre of which shall be a little above the point where the inner border of the sartorius crosses a line drawn from the middle of Poupart's ligament to the inner tuberosity of the femur. The internal saphenous vein should be out of danger on the inner side of the incision. Divide the skin, subcutaneous tissue, and the fascia lata, exposing the fibres of the sartorius, which may be recognized by their direction downward and inward, those of the adductors, on the contrary, being downward and outward. The limb should now be slightly flexed, the vessels recognized by the touch at the inner border of the sartorius, this muscle drawn outward, and the sheath of the vessels pinched up with forceps on the outer side (the vein lying on the inner) and opened. Bell recommends that one edge of the incision in the sheath should be grasped with a pair of spring forceps and confided

FIG. 50.



Ligature of the femoral artery.

to an assistant, while the operator himself holds the other, and carefully denudes the artery with a sharp knife to a very limited extent. He thinks the danger of injury to the vein less than that of failure in consequence of the rupture of too many of the vasa vasorum. The needle is then passed from within outward.

B. *In the Middle of the Thigh.*—Here the vessel lies underneath the sartorius which overlaps it on both sides. The incision is made in the line above mentioned, its centre being a little above the middle of the thigh; the sartorius is exposed and drawn outward after the leg has been further flexed. The vessel is then sought for, exposed, and tied as before.

C. *In Hunter's Canal.*—Abduct and flex the thigh, and rotate it outward so as to make the adductors tense; feel for the tendon of the adductor magnus and make an incision three or four inches long, the centre of which is at the junction of the lower and middle thirds of the thigh, in the direction of the tendon, which is that of a line drawn from the spine of the pubis to the tubercle on the inner condyle of the femur. Divide the skin and subcutaneous tissue carefully so as not to wound the internal saphenous vein, and then the aponeurosis upon a director. Recognize the fibres of the sartorius and of the vastus internus which are at right angles with one another, and by pressing the former inward or the latter outward the tendon of the adductor and the curved glistening fibres arching from it to the vastus internus are exposed. If the saphenous nerve is now encountered it should be traced upward, a director passed into the orifice through which it emerges, and the aponeurosis divided upward; if the nerve is not seen it should not be sought for, but the aponeurosis should be pinched up and divided close to the tendon of the adductor. The sheath of the vessels is now opened, and the artery separated from the closely adherent vein. The needle should be passed from within outward.

Some surgeons prefer to make the first incision in the direction of the artery rather than in that of the tendon.

LIGATURE OF THE POPLITEAL ARTERY.

This is an operation which is required only in the rare cases of rupture of the artery when an attempt is to be made to save the limb. The artery lies very deep between the condyles of the femur, embedded in fat, and directly covered by the vein, the walls of which are thick and stiff like those of an artery. The short saphenous vein perforates the fascia near the centre of the popliteal space, and empties into the main trunk.

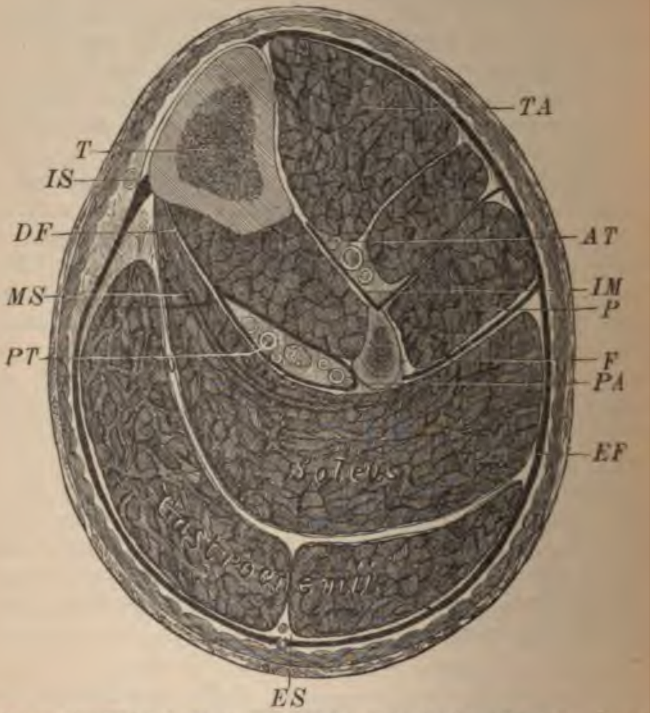
Operation.—Make an incision three or four inches long in the vertical diameter of the popliteal space, the centre of which shall correspond to the point at which the ligature is to be placed. Divide the skin and cellular tissue, taking care not to injure the saphenous vein, and then the aponeurosis to the full extent of the cutaneous incision. Flex the leg, have the sides of the wound drawn widely apart, and work down through the fat and lymphatic glands to the artery, leaving first the nerve and then the vein upon the outer side. Protecting the vein with one finger, denude the artery and pass the needle from without inward.

Jobert (de Lamballe) reached the popliteal artery in the upper part of its course by an incision on the inner aspect of the leg, passing between the tendon of the adductor magnus on one side, and the sartorius, semi-membranosus, and semi-tendinosus on the other. The artery is found lying close to the femur.

LIGATURE OF THE ANTERIOR TIBIAL ARTERY.

Anatomy.—After perforating the interosseous membrane at the upper part of the leg, the anterior tibial runs in a direction which is that of a line drawn upon the anterior aspect of the leg from the upper tibio-fibular articulation to a point midway between the malleoli. It lies at first between the belly of the tibialis anticus and that of the extensor communis digitorum upon the interosseous membrane, afterward between the tibialis anticus and the extensor proprius pollicis or their tendons upon the tibia. It is accompanied by two veins and the anterior tibial nerve, which lies first upon the outer side and then crosses in front to the inner side. It may be tied at any point in its course.

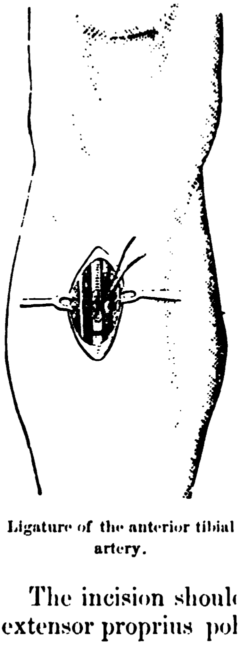
FIG. 51.



Transverse section of the leg, upper third. (Tillaux.) *T.* Tibia. *F.* Fibula. *EF.* En-veloping fascia. *DF.* Deep fascia dividing to inclose. *PT.* Posterior tibial artery an nerve, and *PA.* Peroneal artery. *TA* Tibialis anticus muscle. *AT.* Anterior tibia artery and nerve. *IM.* Interosseous membrane. *P.* Peroneus longus muscle. *IS.* Internal saphenous vein. *ES.* External saphenous vein and nerve.

Operation.—Make in the above-mentioned line an incision the length of which will vary according to the depth at which the artery is placed. Divide the skin and cellular tissue lay bare the fascia, and divide it along the first muscular interstice, which shows as a white line under it; make also a transverse incision through the fascia from the middle o the longitudinal one to the crest of the tibia, so as to give more room. Flex the foot upon the leg, separate the muscles from below upward with the finger, draw them apart with retractors, isolate the artery without raising it, and pass the needle from the side of the nerve.

FIG. 52.



Ligature of the anterior tibial artery.

LIGATURE OF THE DORSALIS PEDIS.

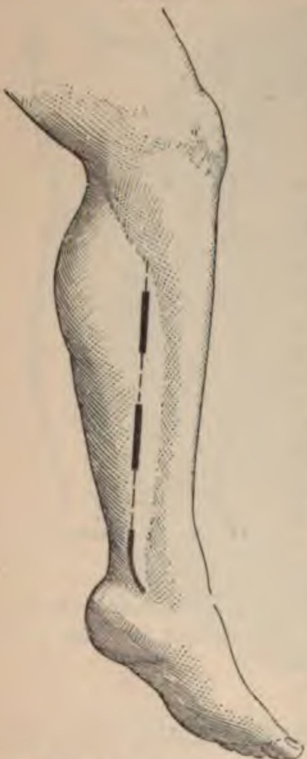
This artery is the continuation of the anterior tibial and passes through the posterior end of the first metatarsal space to the plantar aspect of the foot. It lies on the outer side of the tendon of the extensor proprius pollicis, and is crossed in its lower portion by the inner tendon of the extensor brevis. It is covered by the skin, superficial fascia, the edge of the extensor brevis or its tendon, and a deep fascia. Its direction is that of a line drawn from a point midway between the malleoli to the posterior end of the 1st metatarsal space. The incision should be in this line, and the tendon of the extensor proprius pollicis should be left on the inner side.

LIGATURE OF THE POSTERIOR TIBIAL.

The posterior tibial artery in its upper and middle portions lies upon the tibialis posticus and the flexor communis digitorum, and is covered by the soleus, from which it is separated by the deep fascia. Near the ankle it is covered only by the integument and fascia. In its upper portion it can be reached by two routes: 1, the one employed by Guthrie, and approved of by Spence and Holmes, through the middle of the calf; 2, the one in more common use, from the inner side of the calf.

Operation. (*Guthrie.*)—Beginning at the lower angle of the popliteal space, make an incision six inches in length directly downward, avoiding as far as possible the superficial veins, carry this incision through the soleus, divide the deep fascia, separate the artery from the vein and nerve, which are superficial to it, and pass the needle from their side.

FIG. 53



Ligature of the posterior tibial artery

Lateral Method.—Beginning in the middle of the upper third of the leg, make an incision from four to five inches long, parallel to and half an inch behind the inner border of the tibia. Carry the incision down to the fascia, leaving the external saphena on the tibial side; divide the fascia, draw the gastrocnemius backward, and separate the soleus at its attachment to the tibia, leaving the deep fascia attached to the bone. Raise the heel and flex the leg upon the thigh, draw back the calf, enlarge the incision if necessary, seek the artery and tear carefully through the deep fascia over it; isolate the artery, leaving the nerve on the outer side, and pass the needle between. Tillaux[1] has proposed a modification. Instead of detaching the soleus from the tibia, he passes between it and the gastrocnemius, and then divides the former muscle longitudinally over the course of the artery. If this incision does not at once expose the artery, the vessel must be sought for on one side or the other by pressing back the sides of the incision.

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[1] Anatomie topographique, Paris, 1877, p. 1145.

The centre of the soleus is occupied by an intra-muscular septum parallel to the deep fascia, and sometimes so stout as to be mistaken for it. Close attention is required for the avoidance of this error.

In the Lower Third and Behind the Ankle.—The artery lies midway between the tendo Achillis and the inner edge of the tibia or the malleolus, and is covered by the superficial and deep fasciæ, the latter of which forms the annular ligament at the ankle.

Operation.—Midway between the tendo Achillis and inner edge of the tibia, or a finger's breadth behind the latter, make an incision three inches long parallel to the tibia, if the ligature is to be placed above the ankle, or a curved line parallel to the posterior border of the malleolus, if it is to be placed behind the ankle. Seek the bundle of vessels, tear through the deep fascia covering them, taking great care not to open the tendinous sheaths which lie in front, and pass the needle from without inward.

PART III.

AMPUTATIONS.

Amputations may be *in continuity* (through the bone), or *in contiguity* (through a joint); to the latter the term *disarticulation* is usually applied. The methods of operation are classified as *circular*, *oval*, and *flap*, and the choice of a method is determined by the disposition of the soft parts about the bone, the facility with which the joint can be opened in a disarticulation, the form of the resulting stump, and the position of the cicatrix. The comparative merits of these methods and their various modifications will be discussed in connection with the different operations. They may be essentially modified by accidental circumstances, and by the necessity which sometimes arises, as in cases of injury, of fashioning the flap from such tissues as are available.

CIRCULAR METHOD.

1st Time.—The cutaneous incision should be made at a distance below the point where the bone is to be divided equal to two-thirds of the diameter of the limb at that point. While an assistant draws the skin firmly and evenly toward the root of the limb, the operator passes his hand below and beyond it, and places the heel of the knife upon its upper surface, its point directed toward his own shoulder. He then sweeps the knife entirely around the limb, dividing the skin and subcutaneous cellular tissue, down to the enveloping fascia, and terminating the incision at the point where it began.

2d Time.—*a.* The skin and cellular tissue are retracted and the muscles divided in succession, the deeper ones at higher levels, so that the surface of section forms a cone, the apex of which is directed upward. The muscles whose origins are most distant must be cut long to allow for their greater retraction.

b. (*Alanson's method.*)—The point of the knife is passed obliquely down from the edge of the skin to the bone at the point where it is to be divided, and carried around the limb, always at the same angle with the bone, so as to form the muscular cone by a single incision.

c. (*Cutaneous sleeve.*)—The skin and cellular tissue are separated cleanly from the deep fascia and turned back over the limb, the raw surface outward. The sleeve thus formed is lengthened by drawing it up and dividing its attachments to the fascia, care being taken to include all the subcutaneous cellular tissue in it, until the dissection has nearly reached the height at which the bone is to be divided. The fascia and muscles are then cut through to the bone transversely with a single sweep of the knife, held as for making the cutaneous incision.

3D TIME.—*Division of the bone.*—The soft parts being drawn up and protected by a piece of leather or a cotton band four inches wide and two feet long, split for half its length so as to pass on each side of the bone (called the *retractor*), and the periosteum having been divided circularly with the knife along or a little below the line to be traversed by the saw, the operator places the heel of the saw upon the bone, steadies its edge with the thumb-nail of his left hand, and draws it slowly toward himself, cutting a deep groove in the bone; he then completes the division with a few rapid strokes of the instrument, while the limb is firmly held by two assistants, so as to prevent binding of the saw or splintering of the bone. The periosteum may first be dissected up for half an inch, so as to form a sort of curtain to overhang the end of the bone.

If there are two bones the retractor should be split into three instead of two parts, and the central one passed between the bones. The saw should be first applied to the larger bone and, after cutting a deep groove in it, should be inclined backward or forward, so as entirely to divide the second before completing the division of the first.

OVAL METHOD.

A scalpel is used instead of the amputating knife; the incision is commenced at the level at which the bone is to be divided, is carried downward on one side, across the back of the limb, and upward on the opposite side to the point at which it began. The details will be given in connection with certain disarticulations to which this method is especially applicable.

FLAP METHOD.

The flaps may be single or double, antero-posterior, bilateral, long rectangular (Teale), or skin flaps with circular division of the muscles (modified flap operation). They may be made by transfixion or from without inward. In making a flap by transfixion it is well first to mark its outline by an incision through the skin and cellular tissue with a scalpel, as otherwise there is danger of making its point too narrow or its edges jagged. The point of the amputating knife is then entered at the nearest angle of the incision and passed through to the other, hugging the bone on its way, and the cut made steadily downward and outward, with sawing movements of the knife. It is then reëntered and brought out at the same points, but passing on the opposite side of the bone, and the second flap cut in the same manner as the first. The fibres on each side of the bone which have escaped are then divided, the retractor applied, and the bone sawed through as above.

In cutting a flap from without inward the scalpel must be entered at one of the angles of the base of the proposed flap, carried along a curved line down to the apex of the flap, and thence up to the other angle of the base. The presence of a tumor, or injury to, or disease of, the soft parts may render it necessary to modify the shape of the flap or vary the obliquity of the incision, so as not to include any unfit tissue in the former.

Modified Flap.—In the modified flap operation the flaps include only the skin and subcutaneous cellular tissue dissected off from the deep fascia; the muscles are divided transversely by a sweep of the knife at the base of the flap, the retractor applied, and the bone cleaned and divided a little higher up.

Teale's Method.—In the method to which Mr. Teale's name has been given a very long rectangular anterior flap, comprising half the circumference of the limb and all the tissues down to the bone, is made and doubled back upon itself, thus furnishing a thick pad for the bone and a posterior cicatrix. The method of operating is as follows: (Fig. 67, *B*) A rectangular anterior flap (posterior in the forearm), equal in length and breadth to half the circumference of the limb at the base of the flap, is marked out by one transverse and two parallel longitudinal incisions, the latter involving only the skin, the former being carried down to the bone. The longitudinal incisions should be so placed that the principal vessels and nerves will not be included in this flap, but in the posterior one, which is also bounded by a transverse incision carried down to the bone, and is only one-fourth as long as the anterior one. The two flaps are now in turn dissected up close to the bone, and the saw applied at their base. After the vessels have been secured the long flap is doubled back upon itself, and its square end fastened to that of the other with sutures; two or three points of suture are also required to keep the sides of the short flap and of the reversed portion of the long flap in contact with the rest of the latter.

It is found that by retraction of the short posterior flap the cicatrix is drawn up behind and out of the way of the bone, and that a soft mass without any large vessels or nerves is the result of the partial atrophy of the long flap, and forms an excellent, non-sensitive stump. The principal objection to this method, and one which greatly restricts its applicability, is the great length of the anterior flap, which can be obtained in many cases only by dividing the bone much higher up than would otherwise be necessary.

Long Anterior Flap.—An anterior flap, its length somewhat greater than the antero-posterior diameter of the limb at its base, is cut by transfixion, or from without inward: the posterior muscles and segment of skin are cut straight across a little below the point of division of the bone, and the anterior flap brought down to cover their cut surface. This method furnishes a good covering for the bone, free drainage for the secretions of the wound, and a well-placed cicatrix.

In every amputation it is well to dissect out the main nerve trunks, and cut them off high up between the muscles, so that their ends may not become embedded in the cicatrix or involved in the suppuration.

The choice of one or another method will often be determined by the anatomical and pathological circumstances of the case. When any one may be used, the preference is usually given now to the modified and to the long anterior flap operations.

AMPUTATION OF THE FINGERS.

Phalanges.—When the injury or disease is limited to one or two fingers, and it is of such a nature that the member will be useless, if preserved, the affected phalanx or finger should be removed without hesitation; but usually it is desirable to save as much as possible of the parts, and therefore whenever a choice can be made amputation in continuity is to be preferred to disarticulation higher up. The incisions should be so arranged that the cicatrix will not lie upon the palmar surface, and for this, as well as for anatomical reasons, the principal flap should be taken from the flexor aspect. No special directions are required for amputation or disarticulation of the middle and distal phalanges. For amputation through the shaft the incision may be circular with a longitudinal addition one-third of an inch long on each side, or the single anterior flap by transfixion may be used. In disarticulation it is best to enter the joint from the dorsal side with a narrow-bladed knife, and cut the anterior flap by carrying the knife through the joint and then forward, hugging the bone.

It must be remembered that the folds on the palmar surface of a finger do not correspond exactly to the joints; the first being half an inch beyond, the middle one a line above, and the distal one a quarter of an inch above the articular surfaces, and also that the prominence of a knuckle when the finger is flexed is formed entirely by the head of the proximal and not by the base of the distal phalanx. When the tissues have not become thickened and infiltrated, the articular depressions can also be felt upon the sides.

Amputation through the Metacarpo-phalangeal Articulation.—The articular depression can be found very easily by passing the thumb and forefinger along the sides of the finger, especially if the latter be at the same time drawn forcibly away from its metacarpal bone.

The incision should be commenced over the dorsum of the metacarpal bone a quarter of an inch above the articulation, carried through the interdigital web, and then back on the palmar face to a point a quarter of an inch above the flexor fold (Fig. 54, *C*); a similar incision, beginning and ending at the same points, is made on the other side of the finger, the flaps dissected back, the lateral ligaments divided while the finger is drawn first to one side and then to the other so as to facilitate access to them and at the same time make them tense, and then the tendons and the remainder of the capsule divided as the finger is withdrawn.

Or an incision may be made only on the side corresponding to the right hand of the operator, the flap dissected back to the joint, the lateral ligament divided, the knife carried transversely through the joint, dividing the tendons and the other lateral ligament, and the other flap cut from within outward, care being taken to make it sufficiently broad.

The head of the metacarpal bone should be removed only in cases where it is more desirable to diminish the deformity than to preserve the strength of the hand.

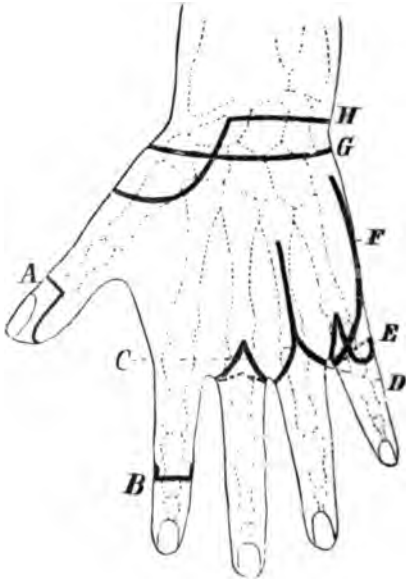
An artery on each side will have to be secured, and the wound closed with sutures.

The incisions may be advantageously modified for the index and little fingers by making a full lateral flap on the free side and carrying the incision transversely across the palmar surface to the angle of the web, and thence obliquely back to the knuckle (Fig. 54, *E*).

AMPUTATION OF THE METACARPAL BONES.

As the articulations of the 1st and 5th metacarpal bones with the carpus do not communicate with the other and larger synovial sacs, these bones may be entirely removed without much danger of setting up inflammation within the wrist-joint, but in the case of the other three amputation in continuity is preferable to disarticulation. The relations of the synovial sheaths of the flexor tendons are also of importance in the operation. There is no communication

FIG. 54.



A. Disarticulation of phalanx, anterior flap *B*. Amputation in continuity, circular. *C*. Metacarpo-phalangeal disarticulation. *D*. Amputation of a metacarpal bone in continuity. *E*. Disarticulation of little finger. *F*. Disarticulation of 5th metatarsal. *G*. Amputation of wrist, circular. *H*. Amputation of wrist. (Dubrueil.)

between the main sheath in the palm of the hand and the sheaths of the 2d, 3d, and 4th fingers, and consequently, if the tendons are divided as low down as the metacarpo-phalangeal articulation, inflammation of the main sheath with all its disastrous consequences will probably be avoided.

The incisions are the same as for amputation through the metacarpo-phalangeal articulation, with a prolongation upward as far as may be necessary over the back of the bone (Fig. 54, *D*). After its posterior and lateral surfaces have been bared, the bone is cut through with pliers at the point determined on, and the distal fragment is raised from its bed, and, beginning at the upper end, its under surface carefully separated from the soft parts.

In disarticulation of the fifth metacarpal, the incision should be made along the inner border of the hand, and carried down to the bone between the skin and the abductor minimi digiti rather than through the fibres of the latter (Fig. 54, *F*). This gives easier access to the palmar ligaments uniting the bone to the carpus. The lower end of the incision should form a loop with its centre in the interdigital web, and its point on the line of the knuckle.

AMPUTATION AT THE WRIST.

(*Radio-carpal Disarticulation.*)

Circular Method (Fig. 54, *G*).—While an assistant retracts the skin upon the forearm, the operator sweeps his knife transversely around the wrist, half an inch below the point of the styloid process of the radius. The skin and as much cellular tissue as possible are divided and dissected back as far as the joint, which is then opened by entering the point of the knife just below the styloid process of the radius, and the disarticulation completed while the hand is drawn firmly away from the arm.

Antero-posterior Flaps.—The absence of muscular fibres at the wrist deprives this method of most of the advantages which it offers at other points, and the projection on the palmar surface of the trapezium and pisiform bones renders its execution difficult, and makes it practically identical with the circular method supplemented by lateral incisions. It should be reserved for cases in which the skin is so infiltrated that it cannot be readily dissected back.

An incision curved downward is carried across the back of the wrist from one styloid process to the other, the flap dissected up, the hand flexed forcibly, the extensor tendons divided, the joint opened beneath them, and the palmar flap, which should extend as far down as the base of the metacarpal bones, cut from within outward.

Or the palmar flap may be made from without inward, or by transfixion, before the joint has been opened.

External Lateral Flap. Dubrueil[1] (Fig. 54, *H*).—The hand is pronated, and the operator makes a curved incision, which, beginning on the dorsal aspect a quarter of an inch below the radio-carpal articular line, at the junction of the outer and middle thirds, passes downward, crosses the outer side of the first metacarpal bone at its centre, and returns to a point on the palmar surface opposite that at which it began. Its two ends are then joined by a transverse incision passing around the inner side below the end of the ulna. The external flap is dissected up, the joint opened at the radial side, and the disarticulation completed.

AMPUTATION OF THE FOREARM.

The forearm may be divided, with reference to surgical considerations, into upper, middle, and lower thirds. Its shape is cylindrical near the elbow, and gradually flattens and narrows toward the wrist. The lower half of the radius and the whole length of the ulna are subcutaneous. The coverings of the lower third are composed almost exclusively of skin and tendons, while thick muscular masses cover the upper two thirds, especially on the anterior aspect. The absence of suitable coverings in the lower third, and the presence there of so many synovial sheaths, the inflammation of which may give rise to dangerous complications, have led some surgeons (Baron Larrey, Sédillot) to advise strongly against amputating at this part. On the other hand, it is important for the subsequent usefulness of the limb that the movements of pronation and supination should be preserved, and this can only be done by dividing the bones below the insertion of the pronator radii teres, which is just above the middle of the radius; if the division has to be made above this point the rule is to save as much as possible, especially the insertion of the biceps.

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[1] Médecine Opératoire, p. 171.

For the reasons stated, the only method applicable to the lower third is the circular one, and if the conicity of the limb or the infiltration of the parts should otherwise render it impossible to carry the dissection of the cutaneous sleeve to a sufficient height, the circular incision must be supplemented by a short longitudinal one in front. The division of the tendons should be on the same level with that of the bone, and is best accomplished by passing the knife under them, and cutting directly outward.

In the upper two-thirds the difficulty of dissecting a cutaneous sleeve is likely to be still greater, and has led to general rejection of the circular method. On the other hand, lateral flaps are impossible, and the bones have a tendency to project at the angles if antero-posterior flaps are made. Many methods have been proposed to obviate this difficulty, in all of which the essential point is the same, namely, to divide the bones at least half an inch above the angles of the incision through the skin. Sédillot made short thin musculo-cutaneous flaps, and divided the deep muscles obliquely according to Alanson's method (p. 91); Richet makes short flaps, including all the soft parts, dissects them up circularly from the bones for about three-quarters of an inch, and divides the latter at the height thus reached. Tillaux recommends short skin flaps to be dissected up for three-quarters of an inch above their base, and then short muscular flaps to be made parallel to the former by transfixion at the higher level. When there is sufficient available material on the back of the arm for a long flap, Teale's method gives good results.

High up in the upper third, where the position of the bones is more central, and thick muscular masses lie upon the sides, the short flaps should be lateral.

AMPUTATION AT THE ELBOW-JOINT.

The guides to the articulation are the epitrochlea on the inner, the epicondyle and the head of the radius on the outer side. The smooth rounded prominence formed by the latter can be readily felt about half an inch below the epicondyle; and the interarticular line starting from it passes at first transversely and then downward and inward toward a point an inch below the epitrochlea, and forms an angle, opening inward, with the transverse diameter of the lower end of the humerus. It is therefore unnecessary to expose the epicondyle and epitrochlea in disarticulating; and these relative positions should be constantly kept in mind during the operation. The skin is freely movable in front, but is adherent to the ulna behind.

The methods in common use are the anterior flap, lateral flap, and circular.

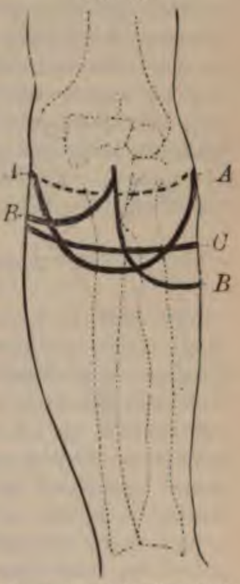
Anterior Flap.—The joint may be opened (*a*) from behind, or (*b*) from in front.

a. From behind. (Sédillot.)—The forearm is flexed, and an incision, slightly convex downward and interesting only the posterior third of the circumference, is made one and a half inches below the tuberosities of the humerus. The skin is dissected up to the tip of the olecranon, the tendon of the triceps divided, the point of the knife passed into the joint and carried first to one side and then to the other, cutting the posterior and lateral ligaments. A longitudinal incision two and a half inches long is then carried downward from the outer end of the first, the forearm, still flexed, is pressed backward and inward, and the disarticulation readily completed by passing the knife through the joint, and cutting down and out on the anterior aspect while the skin is forcibly retracted.

b. From in front. (Fig. 55, *A.*)—The flap may be made by transfixion, or from without inward; in either case it should be at least three inches long, and its base should be parallel to and three-quarters of an inch below a line drawn through the epicondyle and the epitrochlea. Some surgeons prefer to make the line of the base oblique downward and outward, because the muscles on the outer side have their origins at higher points on the humerus, and retract more than those on the inner side. The posterior incision should be slightly convex downward, and should begin and end at the same points as the anterior one.

The head of the radius is then sought for, and the joint opened by entering the knife between it and the humerus and completely dividing the external lateral ligament. The capsule is divided in front by passing the point of the knife along the edge of the ulna over the coronoid process to the internal lateral ligament, which should be cut as high as possible. The olecranon is disengaged from the humerus by drawing it down forcibly, the attachment of the triceps divided, the knife passed behind the bone, and the remaining tissues divided from within outward.

FIG. 55.



Amputation at the elbow-joint. *A.* Anterior flap. *B.* External flap. *C.* Circular method.

Lateral flap. (Fig. 55, *B.*)—An external flap four or five inches long is made by transfixion from a point in the median line in front, a finger's breadth below the bend of the elbow; or from without inward by an incision beginning at the same point and ending half an inch higher on the posterior face of the ulna. A second incision is made transversely across the inner side of the arm about an inch below the upper end of the first. The radio-humeral joint is opened, and the disarticulation completed as before.

Instead of a single external flap, two lateral flaps may be made, but the external should be half an inch longer than the internal one.

Circular. (Fig. 55, *C.*)—An incision, transverse or a little lower on the outer than on the inner side, is made about the limb three and a half inches below the epitrochlea, and carried down to the enveloping fascia; the cutaneous sleeve is dissected up for about an inch, and the muscles divided transversely at its base. They are then retracted forcibly by an assistant so as to form a cone with its apex directed downward, and the deep muscles of the anterior aspect are again divided transversely on a level with the radio-humeral articulation, the external lateral ligament being included in the incision and the joint thereby opened. The disarticulation is completed as before described.

AMPUTATION OF THE ARM.

This may be performed at any point below the attachments of the muscles of the axilla. Disarticulation at the shoulder is preferable to amputation in continuity above these attachments. As the bone is centrally placed and well covered on all sides, any one of the usual methods of amputation may be employed. As a general rule the biceps should be divided at a lower level than the other muscles because it is not adherent to the humerus, and therefore retracts more than the others. The circular incision should be half an inch lower on the inner than on the outer side. In muscular subjects flaps should be cut rather thin, and, when possible, it is better that the main artery should be in the posterior flap.

AMPUTATION AT THE SHOULDER-JOINT.

General Considerations.—The exposed position and great accessibility of the head of the humerus have led to the suggestion of many operative methods, most of which can be performed with much ease and regularity upon the cadaver, and yield good results in actual practice, amputation at the shoulder-joint being, perhaps, the most successful of the major operations. But as the operation is usually rendered necessary by malignant disease or compound fracture of the humerus, or by aneurism of the axillary artery, under circumstances which make it very difficult, if not impossible, to follow regular methods, it is more important to be familiar with the anatomy of the parts and the general principles governing all the methods than with the details of the different ones.

The size of the axillary artery and the difficulty of efficiently compressing the subclavian make the management of the artery an element of prime importance in this operation. The joint should be approached from the outer side, and the artery divided from within outward after disarticulation, an assistant passing his thumb into the wound above the knife and compressing the vessel before it has been cut. Or the artery may be exposed during the operation and tied before it is cut.

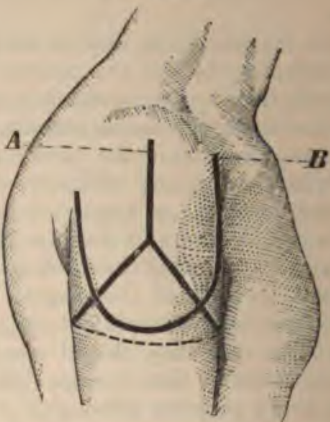
Pressure upon the subclavian may be made by the thumb of an assistant standing behind the patient, or by the well-padded handle of a door key or tourniquet, or a rubber tube or cord tightly encircling the axilla, scapula, and clavicle.

The subsequent retraction of the pectoralis magnus and latissimus dorsi leads to gaping of the wound and the formation of a broad, unsightly, triangular cicatrix. This must be met by retaining all the skin for the first two or three inches in the flaps, not allowing the incisions to diverge from one another until the end of the flap is nearly reached. This precaution also insures ample covering for the projecting acromion. The outer flap should comprise the entire thickness of the deltoid so that the gap left by the head of the humerus may be properly filled, and it should be dissected up close to the bone so as to avoid injury to the trunk of the posterior circumflex artery.

Instead of attempting to separate the capsule at its attachment to the upper edge of the glenoid cavity by passing the point of the knife under the acromion, it is better to divide it near its centre by drawing the edge of the knife across the upper surface of the head of the humerus; and in all incisions beginning between the acromion and coracoid process the point of the knife should be passed directly down to the humerus so as to divide the strong fibrous arch connecting the two processes.

Oval Method (Baron Larrey). (Fig. 56, *A*.)—A longitudinal incision involving all the tissues down to the bone is made on the outer aspect of the shoulder from the edge of the acromion to a point one inch below the neck of the humerus, and an oval one interesting the skin only is then carried from its lower end around the arm, crossing its inner side about an inch below the border of the axilla. The flaps thus marked out are dissected up, the anterior one carefully, until the tendon of the pectoralis magnus is exposed, and divided close to its insertion, the posterior one more boldly, but close to the bone, so as to avoid injury to the trunk of the circumflex artery. The capsule is freely divided across the head of the humerus, the arm rotated inward and then outward so as to facilitate the division of the tendons of the articular muscles, which is best accomplished by cutting directly upon the tuberosities, the humerus thus liberated is thrown outward by adducting the elbow, the knife is passed behind it and carried down and out through the cutaneous incision on the inner side, while an assistant compresses the artery in the wound.

FIG. 56.



Disarticulation at the shoulder. A. Oval method. B. Method by double flaps.

The resulting wound is comparatively small, allows free drainage at its lower angle, is likely to unite by first intention in its upper half, and usually leaves a linear cicatrix.

After cutting through the tendon of the pectoralis magnus, Verneuil isolates the biceps and coraco-brachialis with his fingers, divides them, seeks for the artery, and ties it rather high up before continuing the operation.

It is sometimes not easy to reach and divide the broad tendon of the subscapularis; and when the humerus is broken it is, of course, impossible to use it as a lever to force the head of the bone out of the socket, and this part of the operation may thereby be rendered somewhat difficult. These and the hemorrhage from the branches of the posterior circumflex are the principal objections to this method, which has, nevertheless, yielded excellent results.

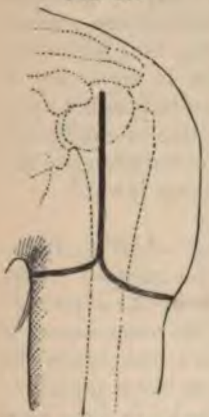
The articulation is uncovered more freely by any of the double flap methods in which an external flap is fashioned out of the deltoid muscle. Of these the Lisfranc method may be taken as the type, premising only that while the opening of the articulation by transfixion is very easy of execution upon the cadaver, it is sometimes impossible upon the living subject, and inapplicable to cases of malignant disease of the humerus. Under such circumstances the flaps must be made by dissection from without inward.

Double Flap Method (Lisfranc). (Fig. 56, *B.*)—Right shoulder. While the arm is abducted the surgeon enters the point of a two-edged amputating knife at the outer side of the coracoid process, carries it across the outer aspect of the head of the humerus, and brings it out a little below the posterior border of the acromion. He then raises the fibres of the deltoid with his left hand, works the knife downward around the head of the bone, and cuts a broad flap about five inches long. In this manœuvre the joint should be opened at its upper part, the tendons of the supra-spinatus and long head of the biceps entirely divided, and those of the subscapularis and infraspinatus partly divided. The arm is then adducted, the knife passed through the joint to the inner side, and a long inner flap cut from within outward.

Left shoulder. The knife is passed in the opposite direction, that is, from below the acromion behind to the coracoid process in front, and the operation completed as on the right side.

Spence's Method.—Prof. Spence has lately introduced a method, for which he claims the following advantages: 1st. The better form of the stump. 2d. The division of the posterior circumflex artery only in its terminal branches in front. 3d. The great ease with which disarticulation can be accomplished. Another advantage is that an operation for excision of the head of the humerus can be easily transformed into a disarticulation by its means, should that be found necessary.

FIG. 57.



Disarticulation at the shoulder. Spence's method.

He describes the operation as follows (Fig. 57):[1] "The arm being slightly abducted, and the humerus rotated outwards, I cut down upon the head of the humerus immediately external to the coracoid process, and carry the incision down through the clavicular fibres of the deltoid and pectoralis major muscles, till I reach the humeral attachment of the latter muscle, which I divide. I then, with a gentle curve, carry my incision across and fairly through the lower fibres of the deltoid toward, but not through, the posterior border of the axilla. Unless the textures be much torn, I next mark out the line of the lower part of the inner section by carrying an incision through the skin and fat only, from the point where my straight incision terminated, across the inside of the arm to meet the incision at the outer part. If the fibres of the deltoid have been thoroughly divided, the flap, together with the posterior circumflex artery, can be easily separated by the point of the finger from the bone and joint, and drawn upward and backward so as to expose the head and tuberosities without further use of the knife. The tendinous insertions of the capsular muscles, the long head of the biceps, and the capsule are next divided by cutting directly on the bone. Disarticulation is then accomplished, and the limb removed by dividing the remaining soft parts on the axillary aspect.

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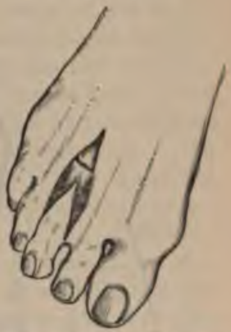
[1] Lectures on Surgery, 2d ed., vol. ii. p. 662. Edin., 1876.

"In cases where the limb is very muscular, I dissect the skin and fat from the deltoid at the lower part, and then divide the muscular fibres higher up by a second incision, so as to avoid redundancy of muscular tissue."

AMPUTATION OF THE TOES.

The different phalanges of the toes may be removed by the same methods, and at the same points, as those of the fingers, but experience has shown that, except for the great toe, it is better to disarticulate at the metatarso-phalangeal joint, the preservation of a portion of a toe being a source of discomfort rather than an advantage. In the case of the great toe it is desirable to save as much as possible, and amputation in continuity is to be preferred to disarticulation. In all operations upon the foot the incisions should be so arranged that the cicatrices will not occupy the plantar surface. It must be remembered that the web between the toes lies far below the metatarso-phalangeal joint. (Fig. 58).

FIG 58.



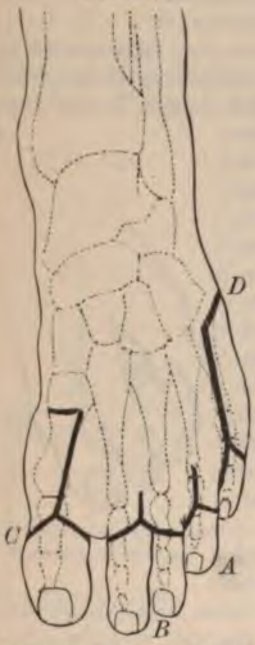
Relations of the web and metatarso-phalangeal joint.

The incision should be commenced on the dorsal surface a little above the joint, carried directly down the bone for about an inch, and then, diverging abruptly, into the web, straight across in the digito-plantar fold, and back on th eother side to the point of divergence (Fig. 59, *A*). If the strong flexor tendons have been completely divided it will then be found easy to disarticulate by entering the knife at the side of the joint. This oval incision is better than the two lateral semilunar flaps, because its cicatrix does not extend into the sole of the foot.

The distal phalanx of the great toe may be removed according to the methods described for the corresponding part of the thumb and fingers (p. 94).

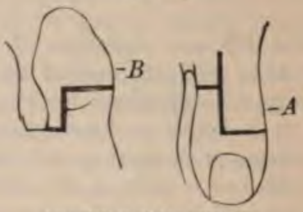
Disarticulation of the great toe at the metatarso-phalangeal joint may be done according to the method just described for the other toes, or with a large internal flap. In the latter case an incision (Fig. 60, *A*) is begun on the outer side of the extensor tendon just below the joint, and carried straight down to the head of the first phalanx. From its lower end a transverse incision is carried around the inner side of the toe to the outer edge of the flexor tendon, and, the toe being then forcibly extended, a plantar incision is carried from the end of the transverse incision (Fig. 60, *B*), along the outer side of the flexor tendon to the digito-plantar fold, and thence transversely around the outer side of the toe to rejoin the first incision near its centre.

Fig. 59.



Amputation of the toes and metatarsal bones

Fig. 60.



Amputation of the great toe.

The internal flap is then dissected from below upward, the extensor tendon divided high up, the lateral ligaments divided, the knife passed through the joint, and the remaining soft parts cut from within outward.

The same incisions made somewhat lower down may be used for amputation in continuity, but usually the shape and position of the flaps will be determined by the nature and extent of the injury which makes the operation necessary.

Amputation of two adjoining Toes.—The dorsal incision should begin in the intermetatarsal space just above the level of the joint (Fig. 59, *B*), extend down to the beginning of the web, diverge obliquely to the adjoining web, cross the plantar surface in the digito-plantar fold of both toes, and return through the other adjoining web to the point of divergence. Each toe is then removed separately after division of its tendons and lateral ligaments.

AMPUTATION OF A METATARSAL BONE.

Amputation in continuity is much to be preferred to disarticulation on account of the extent of some of the synovial sacs, the attachments of certain muscles, and the importance of some of the bones in preserving the relations of the others. The synovial sac which forms part of the articulation between the first cuneiform and first metatarsal bones is isolated from the others, but the attachment of the peroneus longus to the base of the latter bone renders its preservation especially important. There is also a separate synovial sac for the articulation between the cuboid and the fourth and fifth metatarsals. The base of the fifth metatarsal is easily recognized by the prominence which it forms on the outer side of the foot; that of the first metatarsal is three-fourths of an inch anterior to the other, and is the first prominence encountered by the finger when it is passed from before backward along the inner side of the bone.

The incision begins on the dorsal aspect at, or a little below, the point at which the bone is to be divided, is carried down well below the metatarso-phalangeal joint (Fig. 59, *C*), diverges into the web, crosses the plantar surface in the digito-plantar fold, and returns through the other web to the point of divergence. A short transverse incision is made through the skin at its upper end to facilitate division of the bone, which is then effected with cutting pliers or a chain saw after the soft parts have been separated on both sides. The toe is then pressed backward, the cut end of the bone raised, the knife passed behind it, and the operation completed by cutting from within outward. The first and fifth metacarpal bones should be cut obliquely so as to diminish the prominence of the stump.

For *disarticulation of the first or fifth metatarsal bones* the only modification needed is to begin the incision at a correspondingly higher point—at or a little below the tarso-metatarsal joint (Fig. 59, *D*). After the flaps have been dissected up, the joint is opened by dividing the dorsal and interosseous ligaments, and the bone raised and separated from the remaining soft parts.

DISARTICULATION OF ALL THE METATARSAL BONES. (TARSO-METATARSAL DISARTICULATION; LISFRANC'S OR HEY'S AMPUTATION.)

The position and general direction of the tarso-metatarsal articulations, as well as the peculiarity presented by the base of the second metatarsal bone, are sufficiently well shown in Fig. 61 to render a detailed description unnecessary. The guides to the articulation are the projecting bases of the first and fifth metatarsal bones.

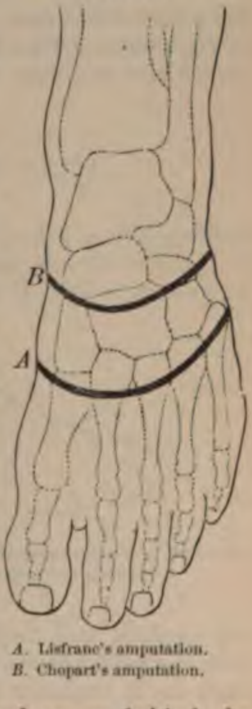
The skin being retracted by an assistant, the surgeon makes with a scalpel a curved incision across the dorsum of the foot from the base of the fifth to the base of the first metatarsal bone. (For the left foot the direction of this incision must be reversed.) The incision should involve the skin only, its centre should lie half an inch or more below the centre of the line of the articulations, and it should begin and end upon the sides of the foot at their junction with the sole. (Fig. 61.)

A plantar flap should then be marked out by a curved incision beginning and ending at the same points as the first and crossing the sole near the origin of the toes. The dorsal skin flap is then dissected back to the line of the articulation, the tendons and muscular fibres of the short extensor divided, the joints between the fifth, fourth, and third metatarsals, and the corresponding bones of the tarsus opened successively from the outer side, and that between the first metatarsal and first cuneiform from the inner side. With the point of the knife directed transversely across the dorsal aspect of the base of the second metatarsal, the joint between that bone and the second cuneiform is sought from below upward, and after it has been found and opened the interosseous ligaments uniting the second to the first and third metatarsals are divided by thrusting the point of the knife well down between them, the flat of its blade being held parallel to the long axis of the foot, and the toes being forcibly depressed.

After the bone has been thus disengaged, the knife is passed through the articulation, and the plantar flap cut from within outward.

Modifications.—The plantar flap may be cut (1) from without inward, or (2) by transfixion, before the articulations have been opened. Instead of disarticulating it, the base of the second metatarsal may be cut off with pliers or a saw and left in place. Hey sawed off the projecting part of the first cuneiform after disarticulating, but this weakens the attachment of the tibialis anticus, a disadvantage which is not offset by the improvement in the outline.

FIG. 61.



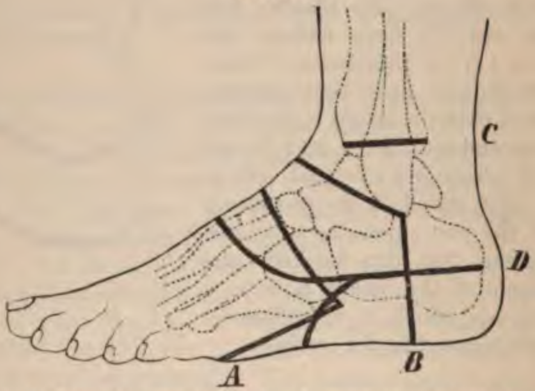
A. Lisfranc's amputation.
B. Chopart's amputation.

MEDIO-TARSAL OR CHOPART'S AMPUTATION.

This name is given to the operation of disarticulation through the joints formed by the astragalus and calcaneum behind, the scaphoid and cuboid in front. The guides to the joint are the tubercle of the scaphoid on the inner side of the foot, the head of the astragalus on the dorsum, and the anterior end of the calcaneum on the outer border. The first named is one-eighth of an inch in front of the articulation, and is the first bony prominence felt on drawing the finger from the inner malleolus forward along the side of the foot; the sharp edge of the second can be readily felt when the anterior portion of the foot is forcibly depressed; the latter can usually be made out by adducting the toes and inverting the sole, nearly midway between the tip of the external malleolus and the base of the fifth metatarsal bone, or nearer the latter. When the foot is at right angles with the leg, the anterior articular surfaces of the astragalus and calcaneum are in the same plane, one crossing the foot transversely at the points indicated.

Operation. (Figs. 61, 62, 63.)—The surgeon places the thumb and forefinger of his left hand upon the tubercle of the scaphoid and the lower and outer border of the cuboid, with the palm against the sole, and makes a curved incision from one to the other passing an inch anterior to the head of the astragalus, and terminating on each side just below the level of the joint. The plantar flap is next marked out by an incision beginning and ending at the same points as the first, and crossing the sole of the foot four or five fingerbreadths nearer the toes. The dorsal flap is next dissected up, the joint entered at either of the points mentioned as guides (preferably between the astragalus and scaphoid on the inner side, after dividing the tendons of the tibiales),

FIG. 62.



Outer side *A* Chopart's amputation. *B.* Syme's amputation *C.* Line of section of the bones in Syme's amputation. *D.* Subastragaloid amputation.

opened widely by dividing the dorsal and interosseous ligaments and depressing the toes, and the plantar flap cut from within outward.

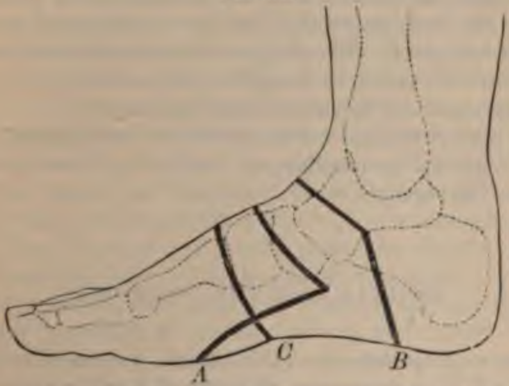
Syme preferred to make the plantar flap by transfixion before disarticulating.

The anterior tendons should be stitched with catgut to the deep tissues, and the dressing should keep the foot in extreme dorsal flexion at the ankle in order that these tendons may so unite with the stump that their muscles will prevent the heel from being raised by the unopposed action of the muscles of the calf.

SUB-ASTRAGALOID AMPUTATION.

(Figs. 62, *D*, and 63, *C*.)—The guides to this operation are the tip of the external malleolus and the head of the astragalus. The joint must be entered from in front on the fibular side, and the strong interosseous ligament which forms the key to the articulation must be divided step by step from before backward and inward. The posterior tibial vessels lie behind the inner malleolus, and must be carefully avoided.

FIG. 63.



Inner side. *A*. Chopart's amputation. *B*. Syme's amputation. *C*. Subastragaloid amputation.

Beginning at the outer side of the heel, nearly an inch below the tip of the external malleolus, an incision, extending through to the bone, is carried straight forward to the base of the fifth metatarsal bone; thence, curving forward, across the dorsum of the foot to the base of the first metatarsal; thence obliquely backward and outward across the sole of the foot and around its outer border, rejoining the first and horizontal part of the incision at the calcaneocuboid articulation. The soft parts must be separated from the outer surface of the calcaneum and cuboid with division of the peroneal tendons, the dorsal flap dissected back to the head of the astragalus, and, on the inner side, beyond the tubercle of the scaphoid, thus dividing the tendon of the tibialis anticus and the anterior portion of the internal lateral ligament. The interosseous ligament can then be easily reached by depressing the toes, passing the knife between the astragalus and scaphoid, and cutting backward and inward along the under surface of the former. The soft parts on the inner side are then separated from the calcaneum, injury to the vessels being avoided by keeping close to the bone, between it and the tendon of the flexor communis, the foot depressed, and the tendo Achillis divided. This last is a very difficult part of the operation, and great care must be taken to keep the edge of the knife close to the bone so as not to cut through the skin.

The posterior tibial nerve should be dissected out and cut off as high up as possible, so that it shall not be pressed upon in the stump.

AMPUTATION AT THE ANKLE-JOINT.

Syme's Amputation, Tibio-tarsal Amputation. (Figs. 62, 63, *B.*)—Amputation through the ankle-joint by the circular method, lateral flaps, or a long anterior flap taken from the dorsum of the foot, as propósed by Baudens, did not meet with favor, because the delicacy of the coverings or the vicious position of the cicatrix rendered the stump practically useless; and, although occasional successes were reported, the choice still lay between Chopart's operation and amputation of the leg, until Prof. Syme, in 1843,[1] showed how the excellent plantar flap could be obtained. About the same time Jules Roux, of Toulon, met the same indication by means of a large internal lateral flap carried across the plantar aspect of the heel.

By greatly restricting the necessity for amputation of the leg this operation has become one of the most important and frequently performed of all amputations. The objections urged against it, and the unfavorable results that have sometimes followed its use, seem to have had their origin in a failure to understand or carry out all the details of its execution, or in the introduction of improper modifications. It has seemed desirable, therefore, to reproduce here Prof. Syme's directions for performing it, as published in 1848,[2] six years after he had first put it into practice.

"Succeeding experience taught me that a much smaller extent of flap than had originally been considered necessary was sufficient for the purpose, and that hence the operation could not only be simplified in performance, but increased in safety from bad effects.

"The foot being placed at a right angle to the leg, a line drawn from the centre of one malleolus to that of the other, directly across the sole of the foot, will show the proper extent of the posterior flap. The knife should be entered close up to the fibular malleolus,[3] and carried to a point on the same level of the opposite side, which will be a little below the tibial malleolus. The anterior incision should join the two points just mentioned at an angle of 45° to the sole of the foot, and long axis of the leg. In dissecting the posterior flap, the operator should place the fingers of his left hand upon the heel, while the thumb rests upon the edge of the integuments, and then cut between the nail of the thumb and tuberosity of the os calcis, so as to avoid lacerating the soft parts which he at the same time gently, but steadily, presses back until he exposes and divides the tendo Achillis.[1] The foot should be disarticulated before the malleolar projections are removed, which it is always proper to do, and which may be most easily effected by passing a knife round the exposed extremities of the bones and then sawing off a thin slice of the tibia connecting the two processes."

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[1] Lond. and Edin. Monthly Journ. of Med. Science, Feb. 1843.

[2] Contributions to the Path. and Practice of Surgery. Edinburgh, 1848.

[3] "The tip of the external malleolus, or a little posterior to it; rather nearer the posterior than the anterior margin of the bone."—Syme, in *Lancet*, 1855.

Disarticulation is accomplished by opening the joint in front and dividing the lateral ligaments by entering the point of the knife between the sides of the astragalus and the malleoli.

The essentials of the method, as pointed out by the more recent Scotch writers (Lister, Spence, and Bell), are that the plantar incision should run from the tip of the external malleolus directly across the heel, should on no account incline forward, and should terminate at least half an inch below the tip of the internal malleolus (behind and below, according to Lister). In case the heel is unusually long the incision may even incline backward. It is not only unnecessary, but actually dangerous, to make the flap longer than this, for it then becomes impossible to dissect out the calcaneum without scoring the subcutaneous tissue in all directions, and increasing the chances of sloughing. If the incision is made further back and carried any higher on the inner side, the posterior tibial will be cut before its division into the two plantar arteries.

Erichsen and Lister both claim that the integrity of the posterior tibial is not of great importance, the vitality of the flap depending mainly upon anastomosing branches of high origin which lie quite near the bone. Erichsen[2] calls attention to the existence of a "branch of considerable size which arises from the posterior tibial artery, about one and a half to two inches above the ankle-joint, and passes down to the inner side of the os calcis," communicating freely above, below, and behind this bone with the peroneal artery on the other side. As these anastomosing loops lie much nearer the bone than the skin, great numbers of them will be divided, and the vitality of the flap endangered, unless the edge of the knife is kept close against the bone during the dissection. Lister goes so far as to say that sloughing of the flap is always the fault of the surgeon, and Bell intimates the same thing.

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[1] It is now generally considered better to divide the tendon from above downward, after disarticulating, keeping the edge of the knife close to the upper and posterior aspect of the bone.

[2] Science and Art of Surgery, vol. i. p. 77. Lea, Phila., 1873.

Roux[1] has shown that this close dissection is not without its dangers from the other side. In two of his cases osteophytes developed within the stump from portions of the periosteum left adherent to the flap. The autopsy in one of these cases showed that six osteophytes had formed and become carious within a year after the operation.

A short longitudinal incision through the deep parts along the middle of the plantar aspect of the calcaneum will sometimes render this step of the operation easier, and be less disadvantageous than the employment of great force.

MODIFICATIONS. A. *Internal Lateral Flap.*—When the outer side of the foot has been so altered by injury or disease that the heel flap cannot be obtained, a very good substitute may be had in the large internal flap suggested by Jules Roux, and adopted with slight changes by Sédillot, Mackenzie, and others. Prof. Spence says this stump can hardly be distinguished from Syme's.

An incision (Fig. 64) is commenced at the outer side of the tendo Achillis, a little above its insertion, carried straight forward under the outer malleolus, then in a curved line across the instep half an inch in front of the anterior articular edge of the tibia, and backward to a point just in front of the inner malleolus; thence directly downward to the sole, across it obliquely backward to its outer border, and then backward and upward around the heel to the point at which it began. The edges of the flaps are next dissected up for a short distance, the joint entered at the outer side, and the internal flap completed from within outward after disarticulation.

Sédillot's modification of this consists in making the flap more quadrilateral than triangular, by a semicircular incision across the dorsum three finger-breadths in front of the malleoli, and by carrying the posterior end of the external horizontal incision across the tendo Achillis to its inner border.

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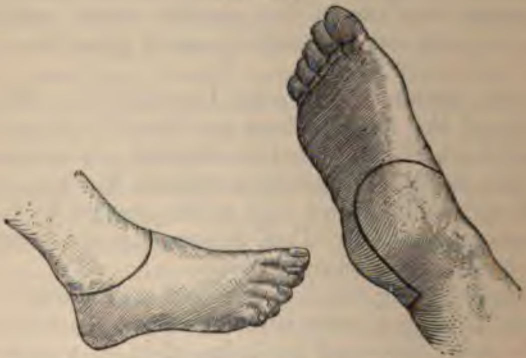
[1] Bull. de la Soc. de Chirurgie, tom. iii. p. 491, 1853.

Mackenzie's method differs only in beginning the incision at the inner border of the tendon and a little higher up.

It is probable that a serviceable *external* flap could be made in the same way, although its vascular supply would be scantier.

B. *Pirogoff's Amputation.*—This is a much more important modification, since it involves not merely the method of performing the operation, but also the retention of the posterior portion of the calcaneum, and its ultimate union with the tibia. The only additional anatomical point that needs mention in connection with it is that the long axis of the calcaneum is directed upward as well as forward.

FIG. 64.

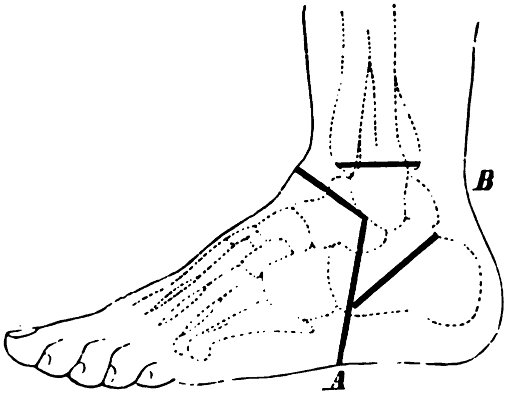


Amputation through the ankle-joint by large internal lateral flap (Roux).

An incision (Figs. 65 and 66, *A*) is made from the tip of the inner malleolus to a point a little above and in front of the tip of the outer malleolus, crossing the instep half an inch in front of the anterior edge of the tibia. A second incision crossing the sole at the level of the calcaneo-cuboid articulation unites the extremities of the first, and should be carried boldly down to the bone. The plantar flap is then dissected back for a quarter of an inch, and the dorsal flap to the edge of the joint, the malleoli well exposed, and the joint opened widely by dividing the lateral ligaments. By drawing the foot forward and depressing it a narrow

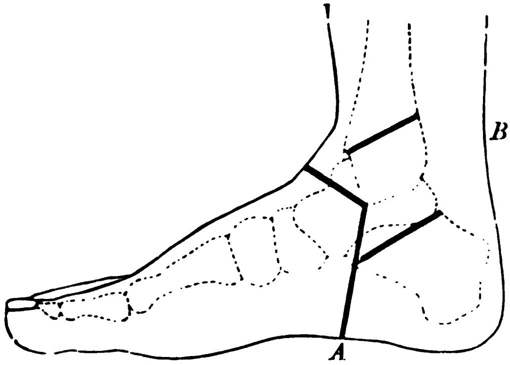
Butcher's or a chain saw can be passed through the joint, and applied to the calcaneum behind the posterior lip of the astragalus, and the bone sawn through downward and forward in such a direction that the section will terminate half an inch behind the lower edge of the calcaneo-cuboid articulation. The malleoli and a slice of the tibia are then re-

FIG. 65.



Pirogroff's amputation. *A*. Cutaneous incision (outer side). *B*. Line of section of the bones.

FIG. 66.



Pirogroff's amputation. *A*. Cutaneous incision (inner side). *B*. Parallel section of the bones (Sédillot's modification).

moved as in Syme's operation, and enough of the anterior angle of the calcaneum removed to make the length of its surface of section correspond with that of the tibia. Some surgeons prefer to reverse this order, and remove the malleoli before sawing through the calcaneum.[1]

The cut surface of the calcaneum must then be brought up against that of the tibia, and if the section of the former has been sufficiently oblique, and has commenced far enough back, this can be done without making excessive tension upon the tendo Achillis, otherwise another slice must be removed from one of the bones or the tendon divided subcutaneously. Suturing together of the bones has been occasionally tried, as has also fastening them together by a long steel pin driven through the skin of the sole and the calcaneum into the tibia.

Several modifications of this operation have been suggested, but they can hardly be considered as improvements. Vertical division of the calcaneum, as originally proposed by Pirogoff and Ure,[2] deprives the stump of the advantages of the heel pad by swinging the latter too far forward, and bringing the weight of the body upon the thinner skin covering the insertion of the tendo Achillis. It also causes undue tension of the tendon when the bones are brought together. Sédillot suggested an oblique section of the tibia upward and backward, parallel to that of the calcaneum (Fig. 66, *B*). This avoids any stretching of the tendon, and insures a well-placed pad under the heel, but it shortens the limb somewhat, and places the point of support behind the axis of the leg. Pasquier saws both tibia and calcaneum horizontally; this is difficult of execution, endangers the flap, and also leaves the point of the heel too far back. The suggestion which is occasionally made to retain the malleoli is unsurgical and unprofitable,—unsurgical, because union between two cut surfaces of cancellous bone is speedier, stronger, and not exposed to greater risks than when one surface is covered with articular cartilage; unprofitable, because nothing is gained in accuracy of adjustment or length of limb.

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[1] Pirogoff's incisions were nearly identical with Syme's. He also divided the calcaneum vertically, and left in the articular surface of the tibia unless it was diseased.

[2] Ure's conception of the operation seems to have been original with him. His case was published in the *Lancet* about the time of the appearance of Pirogoff's book at Leipzig, 1854.

Comparison of the Different Methods of Partial and Total Amputation of the Foot.—As an offset to the advantage of their less extensive mutilation, Lisfranc's and Chopart's amputations are open to the objection that the unopposed action of the muscles of the calf may raise the heel permanently, and bring the weight of the body upon the end of the stump and the cicatrix; and, furthermore, when these amputations have been performed for disease of the bones, those bones which were left behind, even if entirely healthy at the time of the operation, have ultimately become affected.

Syme's amputation gives an excellent stump, and the shortening of the limb is no more than is necessary to permit the adaptation of an artificial foot and a spring under the heel, but it is comparatively difficult of execution, and the flap is liable to pouch and favor retention of the pus. Pirogoff's method is easier of execution and gives a longer limb, but an artificial foot cannot be fitted to it so advantageously, and in cases of amputation for disease it is contrary to sound principles of surgery to leave in the stump any bone which is apt to become subsequently affected; it brings the heel pad a little too far forward, and requires a longer time for recovery from the operation. The subastragaloid disarticulation gives a longer limb and a good stump, but disease is very apt to recur in the astragalus.

(See also Mickulicz's osteoplastic excision of the leg.)

AMPUTATION OF THE LEG.

A. LOWER THIRD.—This may be done by the pure circular or by a modified circular method, with a long anterior flap made to overhang the square-cut posterior segment of the limb, or with a long elliptic posterior flap, including the whole of the tendo Achillis. The two former result in a central adherent cicatrix; in all the coverings are liable to be thin and tender, and the artificial limb must be so adjusted that the weight will be received by the sides of the leg and not upon the face of the stump. The compensa advantages are that the control of the limb is more pe

FIG. 67.

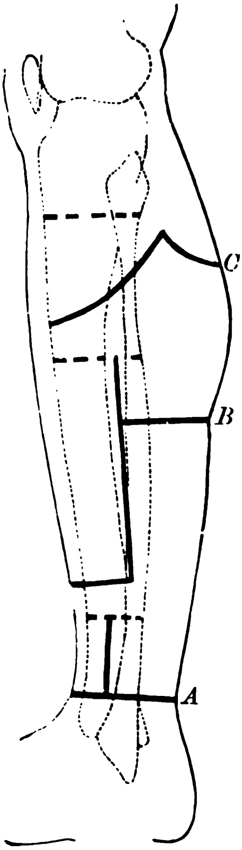

FIG. 68.

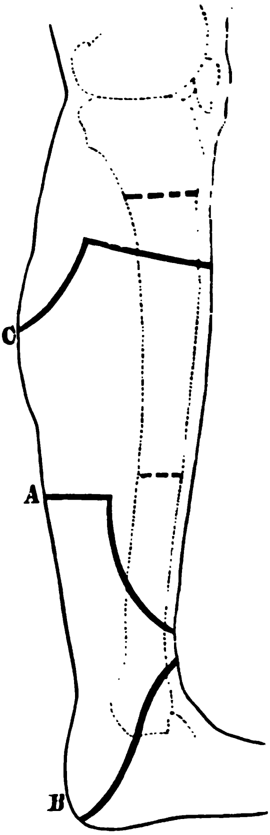

Fig. 67.—Amputation of leg. *A.* Modified circular. *B.* **Rectangular flaps, Te** *C.* Antero-posterior flaps, upper third, Bell.

Fig. 68.—Amputation of leg. *A.* Long anterior flap. *B.* **Supra-malleolar amputa** by long posterior flap, Guyon. *C.* At the upper third, Sédillot.

than with a shorter stump, and the mortality conseque upon the operation less.

1. *Circular Method.*—A circular incision is made through the skin, and a cutaneous sleeve one inch long behind, two inches in front, is dissected up; the soft parts are cut straight through to the bone at the base, and then retracted with a two- or three-tailed band, according to the breadth of the interosseous membrane, and the bones sawn through, beginning and ending with the tibia.

2. *Modified Circular.* Fig. 67, *A.*—Circular incision through the skin, met by a liberating longitudinal one on the antero-external aspect. The soft parts of the posterior portion are divided rather lower than those of the anterior portion, and all are dissected back to the line at which the bones are to be divided.

Instead of a single liberating incision two may be made, one on each side; and then by rounding off the corners we may have double skin flaps with circular division of the muscles, the "modified flap" operation.

3. *Long Anterior Flap* (Bell). Fig. 68, *A.*—An anterior flap, equal in length to the diameter of the leg at its base, is marked out by a curved incision through the skin, beginning at the posterior edge of the tibia on the inner side, a little below the point at which the bones are to be divided, and ending at a point directly opposite over the fibula. The anterior muscles are divided transversely half an inch above the lower end of the flap, and carefully dissected off the bones and interosseous membrane as high as the base of the flap. The separation from the interosseous membrane should be made with the finger or handle of the knife, in order that the anterior tibial artery which lies immediately upon the membrane may not be injured. The posterior flap is then made by transfixion and cutting transversely outward, and, the soft parts being retracted, the bones are sawn across a little higher up.

The resulting cicatrix is posterior and not adherent to the end of the bone. Bell[1] reports five cases, in all of which there was complete and rapid recovery, with a useful stump.

4. *Elliptic Posterior Flap* (Guyon[2]). Figs. 68 and 69, *B.*—The incision is made in the form of an ellipse, whose lower end crosses the heel below the insertion of the tendo

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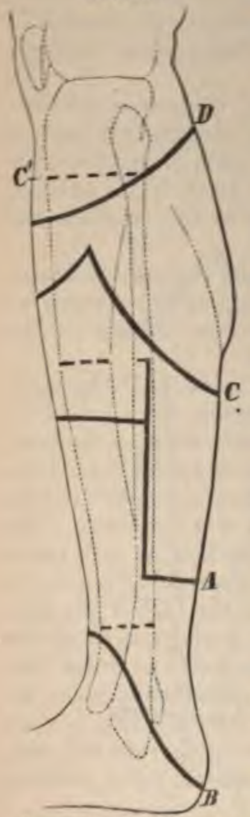
[1] Manual of Surg. Operations, 3d ed., p. 85. Edinburgh, 1874.

[2] Bulletins de la Société de Chirurgie, 1868, page 337.

Achillis, and whose upper end is about an inch above the anterior articular edge of the tibia. Beginning at the lower end and dividing the tendo Achillis at its insertion, and hugging the bone all the way, the flap is dissected up posteriorly as high as the upper end of the ellipse. The anterior muscles are then divided by transfixion, the bones sawn through, and the posterior tibial nerve resected.

In this operation the sheath of the tendo Achillis is not opened, and the tendon itself serves afterward as a covering for the end of the bone. The retraction of the muscles of the calf tends, in course of time, to draw the cicatrix downward and backward, and Farabœuf has proposed to meet this tendency by carrying the anterior end of the ellipse still further up the leg, so that that part of the incision through the skin shall be an inch or so above the line of division of the bones and anterior muscles.

FIG. 69.



Amputation of the leg and at the knee. A. Long posterior rectangular flap, Lee. *B* Supramalleolar, Guyon. *C*. At the upper third, Sédillot. *D*. Disarticulation at the knee, oval incision.

B. MIDDLE THIRD.—1. Long anterior curved flap. 2. Long anterior rectangular flap (Teale). 3. Long posterior rectangular flap (Lee). 4. Simple posterior flap.

1. The *long anterior curved flap* is made according to the method described for its use in the lower third. The principal points to be borne in mind are to separate the anterior muscles from the interosseous membrane with the finger or handle of the knife, to make the flap long enough to fall over and cover the broad posterior surface of section without tension, and to saw off obliquely the prominent angle made by the crest of the tibia.

2. *Long Anterior Rectangular Flap* (Teale).[1] Fig. 67, *B.*—From each end of the transverse diameter of the leg at the point at which the bones are to be divided an incision, equal in length to half the circumference of the leg at that point, is made downward and slightly backward, so that the two shall be as far apart at their lower as they are at their upper ends, measuring across the front of the leg. Their lower extremities are then united by a transverse anterior incision carried through to the bones and interosseous membrane. The flap thus marked out is dissected up to its base, the separation from the interosseous membrane being made with the finger or handle of the knife so as not to injure the anterior tibial artery.

A posterior flap, one-fourth the length of the anterior one, is next cut by a transverse incision straight down to the bones, and dissected back to the same point, the interosseous membrane divided, the bones cleaned and sawn through.

The long flap is then doubled back upon itself, its lower end sewed to that of the posterior flap, and the edges of the lateral incisions fastened together.

3. *Long Posterior Rectangular Flap* (Lee). Fig. 69, *A.*—The incisions are similar to those used in Teale's method, but they involve only the skin, and the long flap is posterior, the short one anterior. The remainder of the operation is described as follows:[2] "When the skin had somewhat retracted by its natural elasticity, an incision was made through the parts situated in front of the bones, which were reflected upward to a level with the upper extremities of the first longitudinal incisions. The deeper structures at the back of the leg were then freely divided in the situation of the lower transverse incision. The conjoined gastrocnemius and soleus muscles were separated from the subjacent parts and reflected as high as the anterior flap. . . . . The deeper layer of muscles, together with the large vessels and nerves, were divided as high as the incisions would permit, and the bones sawn through in the usual way. The flaps were then adjusted in the manner recommended by Mr. Teale.

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[1] See also page 93.

[2] Medical Times and Gaz., June 3, 1865.

"The long flap thus formed is thicker than when taken from the front of the leg, and consequently less liable to slough."

In muscular subjects and when amputating high up, it is sufficient to retain the gastrocnemius alone.

4. *Single Posterior Flap.*—When the muscles have become atrophied a single posterior flap may be safely made. A transverse incision is made across the front of the leg from the posterior edge of one bone to that of the other, and a long posterior flap cut from within outward, by transfixion. Its length should be equal to the diameter of the leg at its base.

C. Upper Third. ("*Place of Election.*")—The bones should never be divided above the attachment of the ligamentum patellæ to the tuberosity of the tibia, and it is better to divide two inches below it, when possible, so as not to open the sheaths of the flexor muscles of the thigh. Baron Larrey preferred to make the section obliquely upward and backward, beginning at the middle of the attachment of the ligamentum patellæ. He claimed that this could be done without opening the knee-joint, and that the greater vitality of the spongy tissue made recovery more rapid. The head of the fibula should not be removed, because in a certain proportion of cases the upper tibio-fibular articulation communicates with that of the knee. The circular and the various flap methods may be employed.

1. *Circular.*—At a distance below the point at which the bones are to be divided one inch greater than half the diameter of the leg at that point, an incision involving only the skin is begun upon the anterior aspect and carried around the leg, crossing the posterior aspect half an inch lower than in front. After dissecting the skin upward for a short distance the gastrocnemii and part of the soleus are divided transversely, and the dissection, including the parts thus divided, carried up to the line of division of the bones, where the remaining muscles and the interosseous membrane are then divided transversely, a three-tailed retractor applied, and the bones sawn through.

2. The long rectangular and the single anterior and posterior flaps, described for the middle third, are also

applicable here. The directions already given in the preceding section are sufficient.

3. *External Flap* (Sédillot). Figs. 68 and 69, *C.*—The point of the knife is entered a finger's breadth external to the crest of the tibia, carried backward and upward, grazing the fibula, and brought out posteriorly as far to the inner side as possible, and at a point an inch higher than that at which it was entered. While the soft parts are drawn toward the outer side with the left hand, a gently rounded flap, four finger-breadths in length, is cut, and its extremities afterward united by an incision slightly convex downward, across the front and inner side of the limb, involving the skin only, which is then reflected, and the anterior and remaining posterior muscles divided transversely at its base. The operation is completed by the division of the bones in the usual manner, and by carefully stitching the edges of the flaps together, leaving the posterior angle open for drainage.

4. *Modified Flap* (Bell). Fig. 67, *C.*—Two equal semilunar flaps of skin three inches long, one antero-external, the other postero-internal, their extremities meeting at opposite points about two inches below the tuberosity of the tibia. These must be reflected up, and with them another inch of skin, embracing the whole circumference of the limb, must be dissected up. The anterior muscles must be cut as high as exposed, and the posterior ones about the middle of their exposed surface. The bones must then be sawn as high as exposed, the fibula being finished first, and the sharp prominence of the edge of the tibia removed.

COMPARISON OF THE DIFFERENT METHODS.

Amputation in the lower third is less fatal than amputation at a higher point, and gives better command of the limb, but the coverings of the stump are liable to be too thin and tender. The circular and double flap methods give central cicatrices and stumps that can bear no weight upon their face, and are sometimes so sensitive that even the pressure of a stocking can hardly be borne. Guyon's long posterior flap taken from the heel promises well; in the first case reported the cicatrix, six weeks after the operation, was two inches above the end of the stump, upon which forcible pressure could be made without causing any pain.[1]

The long anterior flap also yields a cicatrix which is placed posteriorly and out of the way of pressure, and in short it may be said that the reasons which made the upper third the place of election have lost their force since amputation by a long single flap has been shown to be practicable at any point.

In the middle and upper thirds Teale's method has proved very satisfactory, but it requires division of the bones at a higher point than is necessary in the single anterior flap. Lee's modification of the posterior flap has removed the dangers due to the redundancy of muscle and the presence of the main nerves and vessels in the flap, while careful dressing and attention to posture will diminish or entirely remove those due to the posterior position of the flap and its mechanical defects.

After amputation in the upper third the weight of the body may be borne upon the tough skin below the patella, the patient kneeling upon his artificial leg; or the stump may fit into the hollow end of an artificial limb, the upper edge of which will receive the weight from the lower edge of the patella and the broader bony surfaces near the joint. In either case motion at the joint is preserved, and there is no pressure upon the cicatrix.

AMPUTATION AT THE KNEE.

Under this head are ranged pure disarticulations and amputations through the condyles of the femur. In disarticulating, the lateral and crucial ligaments should be divided near their attachments to the femur, and the semilunar cartilages removed. The coats of the popliteal vein are unusually thick and stiff, and its relations to the artery are so intimate that the pulsations of the latter are liable to be communicated to it and to lead to secondary venous hemorrhage, unless the two vessels are separated upward for about an inch.

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[1] In a letter to me, dated June, 1877, Prof. Guyon states that he has amputated four times by this method, and has every reason to be satisfied with the result. The patients bore their weight upon the stump as freely as upon the other foot. Two cases are reported in the *Bull. de la Soc. de Chirurgie*, 1877, p. 321.—L. A. S.

A. DISARTICULATION. *Oval Method* (Baudens). Fig. 69, *D*.—An oval incision crossing the front of the leg five finger-breadths below the end of the patella, and the back three finger-breadths higher than in front, is made through the skin, and the anterior flap, including the flexor tendons on the inner side of the tibia and their fibrous connections, dissected up and reflected until the lower end of the patella is exposed. Then flexing the leg the operator divides the ligament immediately below the patella, and with it all the anterior part of the capsule. He next divides the lateral ligaments and then the crucial ligaments, taking care not to injure the popliteal vessels with the point of his knife.

The tibia is then drawn forward, the knife passed through to the posterior border of the joint, its edge directed downward, and the remaining soft parts divided from within outward.

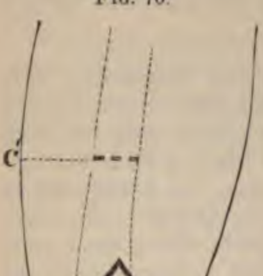
If necessary the popliteal artery can be compressed by an assistant in the flap behind the knife before its division.

Long Anterior Flap. Fig. 70, *A*.—A tongue-shaped flap is marked out by an incision beginning half an inch below the line of the articulation nearly as far back as the posterior border of the condyle on one side, and ending at the corresponding point on the other, after crossing the leg five inches below the patella. A transverse posterior incision unites the sides of the first an inch below its ends. The flap is dissected up and the disarticulation completed as before.

Prof. Pancoast has modified the operation by making inside of a single short posterior flap two small semilunar postero-lateral ones, meeting in the centre of the popliteal space.

B. AMPUTATION THROUGH THE CONDYLES. *Oval Method.*—The incision, similar to that used for disarticulation, ends in front three finger-breadths below the patella, and the joint is opened above instead of below this bone, which is not included in the flap. After disarticulation has been effected, the posterior soft parts divided, and the artery tied, the condyles are sawn through above the edge of the articular cartilage. Or the saw may be applied without having previously disarticulated.

FIG. 70.



Amputation at the knee and lower third of thigh. *A* Disarticulation, long anterior flap *B*. Amputation through the condyles, Carden. *C*. Modified flap amputation at the lower third of the thigh, Syme.

Anterior Flap (Carden[1]). Fig. 70, *B*.—"The operation consists in reflecting a rounded or semi-oval flap of skin and fat from the front of the joint; dividing everything else straight down to the bone; and sawing the bone slightly above the plane of the muscles: thus forming a flat-faced stump with a bonnet of integument to fall over it.

"The operation is simple and is performed easily in two ways.

"The operator, standing on the right side of the limb, seizes it between his left forefinger and thumb at the spots selected for the base of the flap, and enters the point of his knife close to his finger, bringing it round through skin and fat below the patella to the spot pressed by his thumb; then turning the edge downward at a right angle with the line of the limb, he passes it through to the spot where it first entered, cutting outward through everything behind the bone. The flap is then reflected, and the remainder of the soft parts divided straight down to the bone;[2] the muscles are then slightly cleared upward, and the saw is applied. . . .

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[1] British Med. Journal, April 16, 1864.

[2] Lister and Bell recommend a posterior skin flap one inch long.

"Or the flap may be reflected first and the knee examined, particularly if the operator be undecided between resection and amputation. In amputating through the condyles, the patella is drawn down by flexing the knee to a right angle before dividing the soft parts in front of the bone; or if that be inconvenient the patella may be reflected downward. . . .

"The flap falls easily over the end of the bone, and, when united to the posterior integuments by a few pins and sutures, is drawn strongly upward and backward by the greatly retracted flexors, and has a somewhat puckered and redundant appearance at first. . . . Whatever dressing be used, it is of great importance to loosen it and examine the stump early, and to provide carefully for the free escape of serum. I remove the pins and sutures at from twenty-four to forty hours at furthest."

Gritti's Modification.—This is the analogue of Pirogoff's modification of Syme's amputation at the ankle. The articular surface of the patella is removed and the cut surface of the bone applied against that of the femur. The natural mobility of the skin over the patella is preserved, and the usefulness of the stump increased thereby; but it not unfrequently happens that the patella is drawn upward by the quadriceps femoris, and union does not take place between the two bones. Gritti sawed through the femur at the upper edge of the articular surface. Stokes thinks the chances of union between the patella and femur are increased by sawing the latter three-quarters of an inch higher. Von Linhart[1] claims that the stump is better than that obtained by amputation in the lower third of the femur, but not better than that obtained by disarticulation.

A rectangular anterior flap (Fig. 71, *A*) extending from the centre of the condyles to the tuberosity of the tibia is marked out, and dissected up after division of the ligamentum patellæ as near as possible to its insertion; the skin covering the back of the knee is divided transversely, or by an incision curved slightly downward, the anterior flap turned back, the synovial membrane separated from its attachment to the femur, and the bone sawn through well above the edge of the articular cartilage, but below the medullary canal. The remaining soft parts are then divided from within outward, and the vessels secured. The articular surface of the patella may be sawn off or removed with cutting pliers, and this step in the operation is facilitated by having the ligamentum patellæ cut long, so that it can be used to hold the bone firmly.

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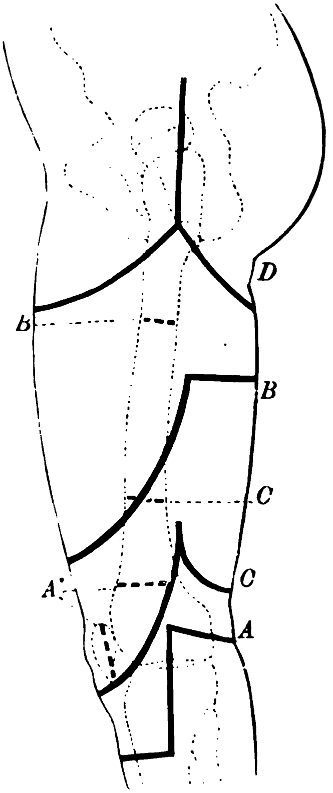
[1] Compend. v. Operationslehre, 1867, p. 401.

FIG. 71.



A. Gritti's amputation at the knee. *A'*. Lines of division of the bone. *B*. Long anterior flap (Sédillot). *B'*. Division of bone. *C*. Amputation at lower third (Spence). *C'*. Division of the bone *D*. Disarticulation at the hip.

AMPUTATION OF THE THIGH.

The central position of the femur, and the abundance of the soft parts have made it possible to employ a great variety of methods of amputation, but the superiority of the flap operation is now generally admitted, with certain modifications depending upon the portion of the limb selected for amputation. Thus, in the lower third when the skin over the patella is uninjured, Teale's or Carden's method is to be preferred; when, on the other hand, that portion of skin is unavailable, the long anterior flap, or Syme's modified flap operation, should be used; and in order to compensate for the greater retraction of the posterior muscles they should be cut obliquely instead of transversely in the former operation, and on a lower level than the anterior muscles in the latter. In the middle third the long anterior flap is to be preferred. Lateral flaps should always be avoided on account of the tendency of the bone to project at the upper angle, drawn forward, as it is, by the action of the flexors of the thigh upon the pelvis.

The muscles are more abundant on the inner and posterior aspects, and this disproportion increases toward the hip. The femoral artery will be found in the posterior flap below the middle of the thigh, in the anterior flap above; care must be taken not to include the internal saphenous nerve in the ligature placed upon it. The profunda artery lies close behind the bone, but divides early into its branches. The sciatic nerve lies between the short head of the biceps and the adductor magnus; it should be drawn gently downward and divided again high up.

Sometimes the band of the tourniquet prevents the muscles from retracting sufficiently to allow the bone to be cleared to the proper height. Under such circumstances the bone should be divided wherever it is most convenient, and the excess sawn off after the vessels have been tied.

Teale's and *Carden's methods* have been sufficiently described. (See pp. 93, 130.)

Modified Flap Operation in the Lower Third (Syme). (Fig. 70, *C.*)—Two equal semilunar flaps of skin and fat, one anterior the other posterior, are made, raised from the fascia, and retracted two inches further; "the muscles should then be divided right down to the bone, on a level as high as they are exposed in front, as low as they are exposed behind." The bone is then cleared and sawn through two inches above the level of division of the anterior muscles.

Long Anterior Flap.—Sédillot,[1] writing in 1854, says he has used this method exclusively for the preceding seven years. Spence[2] describes a method as first practised by himself in 1858, and claims that his "flap is formed on a principle essentially different from that which regulates the construction" of Sédillot's, a difference which is not recognizable in the descriptions, the length of the flap in each case being equal to the diameter of the limb, the breadth of its base "almost two-thirds of the circumference" according to Sédillot, "fully equal to one-half the circumference" according to Spence, and the muscle contained in it cut obliquely by both, so that it shall not be too thick. Sédillot divides the posterior segment of the limb transversely. Spence divides it obliquely from without inward, beginning two inches below the base of the anterior flap, and sometimes takes an additional inch of skin, a difference which approximates his method to Teale's. Benjamin Bell also describes a method which is nearly identical, and O'Halloran used a similar one in 1765, but his flap was too short to accomplish its purpose.

Sédillot's description is as follows (Fig. 71, *B*):

The flesh of the anterior aspect of the limb is grasped in the left hand, and an incision made through the skin, marking out a flap whose length is equal to one-third, and its base to almost two-thirds of the circumference of the limb. The muscles are then divided obliquely upward and backward so that the flap shall not be too thick, the posterior segment of the limb divided transversely, the bone cleared an inch or two higher and sawn through. He also removes the anterior edge of the bone obliquely, as was recommended for the tibia.

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[1] Médecine Opératoire, 2d edition, vol. i. p. 455.

[2] Lectures on Surgery, 2d edition, vol. ii. p. 621, Edinb., 1876.

Spence recommends the long anterior flap as especially applicable to amputation in the lower third, and he makes it as low as possible, so that its lower margin is on a level with or below the patella. After dissecting up the skin to the upper end of the patella, he cuts obliquely upward through the anterior muscles to the bone immediately above the condyles (Fig. 71, *C*). While the soft parts are retracted, and after the bone has been cleared circularly, he elevates the femur so as to project it fully, and divides it two inches above the base of the flap.

AMPUTATION AT THE HIP-JOINT.

The affections which render this most serious operation necessary are often of such a nature that the surgeon's choice of a method of performing it is greatly restricted; he must take his flaps where he can get them, and must regulate his incisions by existing lesions. Moreover, the problem is not to obtain a flap that will bear pressure, but to remove the limb in the manner that involves the least risk to life. This risk, which has proved very great, is due not only to the gravity of the lesions which render surgical interference necessary, but also to three causes which originate in the operation itself. These are loss of blood, shock, and septicæmia; the first two being together responsible for about as many deaths as the third.

The opinion, held by many, that the amount of shock varied directly with the length of time employed in removing the limb, led to the introduction of operative methods characterized by extreme rapidity of execution, not more than thirty seconds being allowed for the removal of the limb from the body; the type of these is the method by a long anterior flap made from within outward by transfixion.

To prevent hemorrhage many expedients have been employed: the same rapidity of execution; compression of the femoral artery upon the pubis, or within the flap by an assistant who passes his fingers into the wound behind the knife; compression of the aorta; preliminary ligature of the femoral artery; ligature of each vessel when encountered in the wound. The hemorrhage most to be feared is that from the numerous vessels of the posterior segment of the thigh, for, while the femoral artery can usually be controlled without much difficulty, there is no way of preventing the flow of blood from the others except by compression of the aorta through the walls of the abdomen, or of the internal iliac through the rectum. The latter device, first suggested as a means of hemostasis during operation for gluteal aneurism, has recently been employed in one or two amputations with success; compression of the aorta, although effectual and entirely harmless in some cases, has proved dangerous or impracticable in others[1] by exciting peritonitis or interfering with respiration.

In a well-written paper read before the Académie de Médecine, 30th October, 1877, Prof. Verneuil[2] reported four disarticulations at the hip-joint performed by himself, and expressed himself strongly in favor of "operating as if for the removal of a tumor," that is, by cutting from without inward, and tying each vessel when it is encountered; by this means he thinks the proportion of deaths occurring within the first few hours or days as the result of hemorrhage or shock (which last, by the way, he thinks is itself largely the result of hemorrhage) could be greatly diminished.

The third cause of fatal results, septicæmia, was thought by Verneuil to be engendered especially by the retention of decomposing secretions in the anfractuosities of the wound, a retention which the ordinary means of drainage cannot prevent; and as the two methods of dressing wounds which claim to prevent decomposition of the secretions, Lister's and Guérin's, cannot be properly applied to so short a stump, Verneuil sought to overcome the difficulty by leaving the wound open and not placing any sutures, in order that the drainage might be free, and also by dressing the wound with some antiseptic. For the sake of drainage he rejected the anterior flap and the modified oval methods, and gave the preference to the lateral flaps, or, still better, the so-called "anterior oval," in which the raw surface is directed forward. The dressing was as follows: 1st, a layer of small pieces of tarlatan covering the entire raw surface; 2d, a thick layer of charpie saturated with an antiseptic solution, alcohol, carbolic acid, or camphor; 3d, a layer of cotton batting covered with oil silk, and a simple retaining bandage. The cotton is turned back several times during the day, and the lint moistened with the disinfecting solution.

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[1] See Erskine Mason, Two successful Cases of Amputation at the Hip-joint, *N. Y. Med. Journ.*, Dec., 1876.

[2] Bulletin de l'Académie de Médecine, 1877, p. 1132.

The position of the joint may be determined by that of the anterior inferior spine of the ilium, which is three-quarters of an inch above its upper margin.

Anterior Oval Method (Verneuil[1]).—The patient having been anæsthetized and placed upon the table, an Esmarch's elastic band is applied from the toes as far upward as is allowed by the nature of the lesion and the line of the proposed incision.

1. An incision, beginning a finger's breadth below Poupart's ligament, is carried down along the course of the femoral artery for about two inches; thence outward and downward, crossing the great trochanter near its base, to the gluteal fold; thence transversely along this fold to the inner side of the thigh, and thence obliquely upward two full finger-breadths below the genito-crural fold to the point where it diverged from the line of the artery. The incision should involve only the skin and the cellular tissue; any vessels that are divided should be immediately tied.

2. The sheath of the vessels is opened, the artery isolated and denuded, and its point of bifurcation determined. A ligature is then applied methodically to the vessel above the origin of the profunda, and a second, lower down, including both branches *en masse*, and the artery divided between them. The femoral vein is also carefully denuded and divided between two ligatures at about the same level. Verneuil considers the ligature of the femoral vein indispensable, but it must be done with the utmost care and gentleness, in order that the phlebitis may remain limited to as small a portion of the vessel as possible.

3. The incision is carried down through the muscles,

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[1] Bulletin de l'Académie de Médecine, 1877, p. 1159.

beginning on either the outer or inner side, as is most convenient; on the inner side, after having cut through the adductors at the junction of their fleshy and tendinous portions, seek and tie the obturator vessels, divide the pectineus and psoas on a line with the neck of the femur, and secure all the bleeding points. On the outer side, divide the sartorius and the fascia lata, and then adduct the thigh so as to throw the great trochanter forward and facilitate the division of the muscles attached to it.

4. Open the articulation in front and divide the posterior portion of the capsule as close as possible to the femur, together with the remaining tendons that are inserted in the great trochanter.

5. Division of the posterior segment of the limb. Depress the thigh beyond the border of the table, so as to make the wound gape widely, and divide the remainder of the adductors and the muscles attached to the ischium with gentle strokes of the knife, tying each vessel when it is recognized or divided. It is well also to resect the extremity of the sciatic nerve.

The resulting wound is conical and gapes widely, for, notwithstanding the laxity of the tissues, there is not enough material left to allow the sides of the wound to be brought together without undue tension, if the surgeon should wish to do so. Verneuil considers this a positive advantage, for not only does cicatrization go on rapidly, but septicæmia is less likely to occur in a well-exposed wound from which the secretions escape freely.

Circular Method.—The patient lying upon his back with his thigh overhanging the end of the table, a circular incision is made through the skin, six inches below the anterior superior spine of the ilium, the skin retracted, and the muscles divided successively at higher levels, until the femur is reached. The capsule is then divided in front and on the sides, close to the edge of the cotyloid cavity, the head of the femur dislocated forward, the knife passed behind it, dividing the ligamentum teres, the remainder of the capsule, and the muscles attached to the neck and trochanter.

Anterior Flap.—The position of the patient being the same, and the thigh slightly flexed and abducted, the point of a long amputating knife is entered midway between the anterior superior spine of the ilium and the top of the great trochanter and passed inward and backward to a point one inch below and in front of the tuberosity of the ischium, grazing the anterior surface of the neck of the femur, and certainly opening the capsule of the joint if its edge is kept turned obliquely toward it. (The direction may be reversed for the right thigh, the knife being entered on the inner side.)

A well-rounded flap ending at the junction of the upper and middle thirds of the thigh is then cut with rapid sawing movements of the knife, and reflected upward. The limb is forcibly depressed, and if the capsule has been well divided this movement will throw the head of the femur forward out of the socket; if not, a single cut with the knife across the head of the bone will free it. The leg is then rotated inward so as to bring the trochanter forward, the surgeon passes the knife behind the head of the bone and cuts a short posterior flap from within outward.

Prof. Van Buren divided the posterior segment from without inward by a sweep of the knife as in a circular amputation, and then disarticulated and divided the rotator muscles with a scalpel.

In the flap operation by transfixion the assistant who compresses the artery against the pelvis with one hand should follow the knife with the other, and grasp the vessel in the flap between his fingers and thumb, and his control of it should be such that the surgeon can give his attention first to securing the numerous vessels of the posterior segment, the bleeding from which may be partly checked by pressure with dry sponges or cloths while the ligatures are being applied. Or the bleeding points may be caught up rapidly with artery forceps, and the ligatures not applied until after all have been thus secured.

Modified Oval Method. Fig. 71, *D.*—The patient is laid upon his side, his hips at the foot of the table. A straight incision three inches long is begun one inch above the summit of the great trochanter, and carried along its posterior border, and a circular incision is then carried from the lower end of the first around the thigh, passing three inches below the tuberosity of the ischium. These incisions should interest the skin only, their borders should be dissected up for about an inch, and the muscles of the outer aspect divided obliquely upward toward the joint. In front this division should not be carried beyond the outer edge of the rectus muscle, but posteriorly it should be as extensive as possible and close to the bone.

The thigh being flexed and adducted, the capsule is opened, first longitudinally on the finger as a guide, then forward and backward along the edge of the cotyloid cavity, the head of the femur dislocated backward and outward, the knife passed around it and brought down along the inner side of the bone nearly to the level of the circular incision, and then made to cut its way rapidly out on the inner side.

PART IV.

EXCISION OF JOINTS AND BONES.

Excision of a joint may be (1) *complete* or (2) *partial.* In the former case the articular ends of all the bones composing it are removed; in the latter, one or more are retained. Again, partial excision may consist of (1) partial or (2) total resection of the articular end of one of the members of the joint. The former is always unadvisable; the latter, to which Ollier[1] has given the name of *semi-articular resection*, has given good results in traumatic cases, and of late also, under antiseptic treatment, in tuberculous affections when the disease is still restricted to a portion of the bone and capsule.

Excision of a bone may be *total* or *partial*, and, in the case of the long bones, with or without either or both epiphyses.

The term *resection* is often employed as a synonym of excision. In the narrower sense it refers to the removal of a portion of a bone, including however its entire thickness; thus, a joint is excised by the resection of the bones composing it.

Joints are excised on account of injury, disease, or anchylosis in a faulty position; and with the object of obtaining a movable joint, as in the upper extremity, or anchylosis as at the knee and ankle. The operative procedures may vary with these causes and these objects. Thus, when anchylosis is sought for, the division of the muscles and tendons about the joint is of no special moment; but if the joint is to be reëstablished, the muscles which control its movements must not be disabled. In any case the main bloodvessels and nerves must be respected; the incisions, whenever practicable, should be parallel to the long axis of the limb; and when it is necessary to divide a tendon or muscle, the line of section should be oblique rather than transverse, so as to favor reunion.

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[1] Congrès Medical de France, 4th session, 1872, p. 224, and Bull. de la Soc. de Chirurgie, 1873.

The incisions should be sufficiently free to allow the bone to be thoroughly inspected with a view to the removal of all the diseased portion. It is better to make a clean division with the saw than to remove the bone piecemeal, but the use of the gouge is proper for the removal of small circumscribed areas of disease found upon the surfaces of section. Roughening of the outer surface of the bone due to healthy plastic processes must not be mistaken for caries.

The synovial membrane in traumatic and non-tuberculous suppurative cases does not require special attention; in tuberculous cases and when much thickened it should be cut or scraped away so as to remove such foci of infection as may exist within its wall or in the fungous granulations on its surface. When anchylosis is sought for, as at the knee, it is prudent to dissect out the sac entirely. If any portion is necessarily left the destruction of the foci should be sought by thorough scraping, washing with a solution of chloride of zinc, 1 to 30 or 40, or of corrosive sublimate, 1 to 1000, or by the actual cautery.

The propriety of retaining the periosteum is still a subject of discussion, and one in which the decision will probably vary with the articulation and the circumstances of the case. Certain facts have, however, been already established. Its retention is a safeguard against injury to neighboring tissues during the operation; after excision of a bone it gives firmness to the cicatrix, diminishes the shortening of the limb, and insures the proper attachment of the muscles; and in the case of an articulation, if its relations with the capsule are maintained (*periosteo-capsular excision*), it favors the reproduction of the joint with articular cartilages and ligamentary support. On the other hand, the reproduction of bone is not always desirable, and may be excessive or irregular, unduly limiting the motions of the joint, or even causing anchylosis; and finally, the bruising received by the periosteum during the operation may cause it to slough, or the reproduction of bone may fail entirely.

Von Langenbeck[1] has shown that in excision of the shoulder-joint it is of the utmost importance to preserve the relations of the periosteum, the capsule, and the tendons of the capsular muscles, but in all other joints, except perhaps the hip, the importance is not so great, or, at least, so well established. Complete restoration of the shoulder-joint and reëstablishment of the control of the muscles over it has never been accomplished except by the subperiosteal method. The periosteum can be removed without difficulty except when it is actively inflamed; its connection with the bone is very slight in cases of chronic osteitis and synovitis. The tendons, on the other hand, are so firmly attached to the bone that the elevator, or rugine, is sometimes insufficient to remove them properly, and the knife must then be used, its edge being kept as close as possible to the bone. Von Langenbeck goes so far as to say that the success of a periosteo-capsular excision depends in great part upon the proper alternation in the use of the knife and elevator.

Vogt and Kœnig strongly recommend that, instead of separating the tendons and ligaments from the bone, the latter should be cut through with a chisel so as to leave a shell attached to the soft parts. In children, where the epiphyses are still cartilaginous, this section can be made with the knife.

Excision of single bones may be required on account of injury or disease. The latter is by far the most common cause, and its most common examples are caries of the small spongy bones and necrosis of the long ones due to acute osteomyelitis or periostitis. The incisions should be made from the side where the coverings of the bone are fewest and of least importance; the periosteum should be left behind, and all the diseased bone should be removed. When the entire shaft of a bone has become necrotic, it must be divided with the chain saw or cutting pliers, and each piece pulled or cut away from its epiphysis.

An instrument recently (1884) invented in England, and called an *exsector* (Fig. 72), promises to be of great service as a substitute for the keyhole or chain saw. My experience with it is limited but very favorable.

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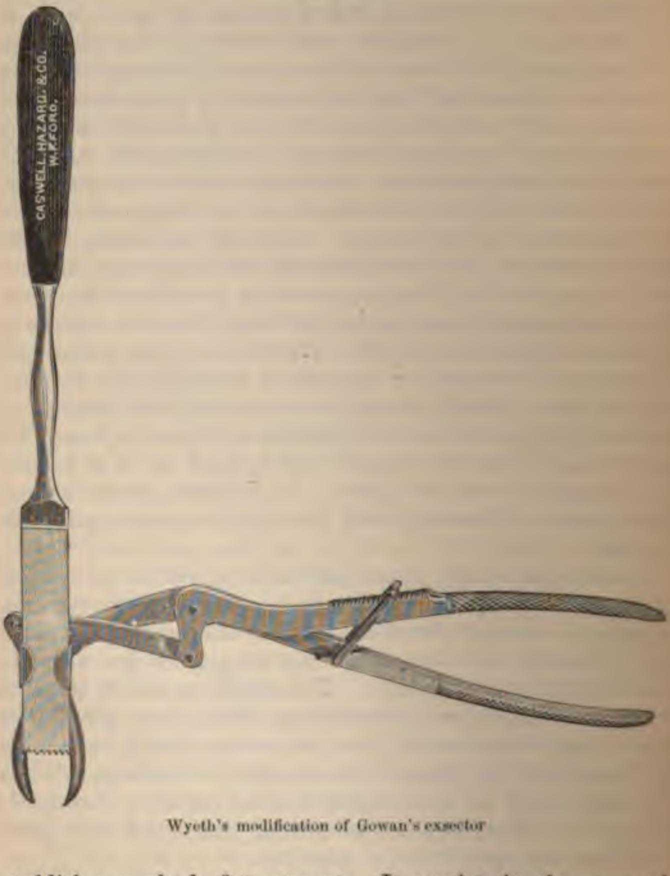
[1] Archiv für Klinische Chirurgie, vol. xvi.

The term *évidement de l'os* has been given by the French writers to a procedure upon which Sédillot attempted to

FIG. 72.



Wyeth's modification of Gowan's exsector

establish a method of treatment. It consists in the removal by the gouge of all the central portion of a carious spongy bone, an epiphysis, or even the shaft, leaving only the presumably healthy shell attached to the periosteum. Although it has proved faulty as a method, it is a useful adjunct to excision.

In cutting down upon carious bone or a sequestrum it is well to keep a probe in the sinus leading to it, as it is sometimes very difficult to find the hole in the bone after the blood has begun to flow.

MAJOR ARTICULATIONS.

EXCISION OF THE SHOULDER-JOINT.

As formerly performed, excision of the shoulder-joint was an operation the results of which, to quote Holmes,[1] were "probably inferior—certainly not superior—to those of natural anchylosis." If anchylosis did not follow, the joint was loose, under slight control, and, at the best, could not be raised above the horizontal line. Ollier[2] and Von Langenbeck,[3] however, have shown that the periosteo-capsular method furnishes a much larger measure of success. In a case operated upon by the former where four inches of the humerus was removed, the ultimate shortening was only half an inch, and the motions were quite full; and the latter reports several cases in which the arm could be raised to the vertical line, and the control of the limb was perfect. In all of Von Langenbeck's cases the operation was undertaken on account of gunshot injury.

As the capsular muscles are attached to the greater and lesser tuberosities, the capsule and periosteum must be divided between these two bony prominences, that is, in the direction of and near to the tendon of the long head of the biceps. An anterior incision beginning at the acromio-coracoid triangle is the best one for this purpose, and has, moreover, the advantage of sparing the posterior circumflex artery and nerve. The cephalic vein lies in the groove between the deltoid and pectoral muscles, and is avoided by making the incision incline outward. When the soft parts are much thickened and consolidated, this incision needs to be supplemented by a short transverse one (Fig. 73, *B*) running outward from its upper end parallel to and just below the edge of the acromion, dividing the fibres of the deltoid transversely in its course; sometimes the condition of the parts is such, and the sinuses so placed, that a large external flap, with its base directed upward, has to be made by a triangular or curved incision, and raised up so as freely to expose the outer aspect of the head of the humerus. In any case the trunk of the posterior circumflex artery should be spared. It is embedded in loose cellular tissue, and when cut may retract so far that a ligature cannot easily be placed upon it.

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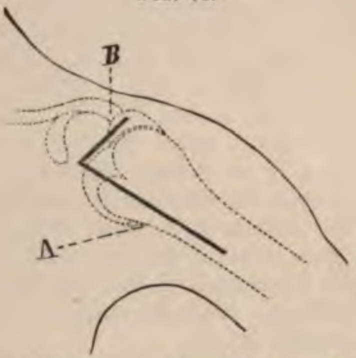
[1] Surgery, its Principles and Practice, p. 929. Lea, Phila., 1876.

[2] Traité de la Régénération des Os, and Des Résections des Grandes Articulations. 1867.

[3] Archiv für Klinische Chirurgie, 1874, vol. xvi.

Fig. 73.



Excision of the shoulder (Ollier). *A* Regular incision. *B*. Supplementary.

The condition of the glenoid cavity seems to affect the prognosis seriously. In eight fatal cases collected by Hodges,[1] it had been interfered with in all but one. Consequently it should not be touched unless actually diseased, and the interference should, if possible, be limited to the use of the gouge.

Spence makes a counter-opening behind for drainage, but this seems to be unnecessary.

Operation (Ollier). Fig. 73.—The arm is abducted and rotated inward. The point of the knife is entered at the beak of the coracoid process, and carried four inches downward and outward in the general direction of the fibres of the deltoid, or as much further as may be necessary. The incision thus made will be external to the inner border of the deltoid, and should comprise all the tissues down to the bone.

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[1] Excision of Joints, Boston, 1861.

The edges of the wound are held apart with retractors, and the capsule and periosteum are divided along the outer edge of the tendon of the long head of the biceps and the bicipital groove to the full extent of the external incision. The outer edge of the incision is raised, and the periosteum, together with the capsule and tendons of the muscles inserted upon the greater tuberosity, is carefully detached with the elevator and knife, while an assistant rotates the arm inward to increase the extent of and facilitate the dissection.

The tendon of the biceps is then raised from its groove and held out of the way, the arm rotated outward, and the periosteum, capsule, and tendon of the subscapular dissected off in the same way on the inner side.

The head of the humerus is then dislocated forward, the posterior attachments of the capsule separated with the elevator or knife, the periosteum peeled off the posterior face of the neck and shaft of the humerus, and the bone sawn through transversely with an ordinary or a chain saw.

If the articular surface of the glenoid cavity is affected, it must be scraped; if the bone itself is diseased, it should be gouged out until healthy bleeding bone is reached, or the neck may be cut through with strong cutting pliers after removal of its periosteum.

Von Langenbeck's method differs slightly from the above. He begins his incision at the anterior border of the acromion just outside of the acromio-clavicular junction, and carries it directly downward, the arm being so held as to bring the outer condyle of the humerus in front. This sacrifices the inner fibres of the deltoid by severing their nerves. He carries the incision through the muscle down to the capsule and bone, then raises with pronged forceps the sheath of the tendon of the biceps, which presents in the line of the incision, and opens it carefully from without inward. As soon as the shining tendon is seen he slits the sheath throughout the entire length of the incision, opening the capsule quite up to the acromion, and exposing the articular end of the humerus with the tendon lying upon it.

He then raises the periosteum on the inner side until the lesser tuberosity is reached, lays aside the elevator, and peels off the tendon of the subscapular with knife and pronged forceps, taking the greatest pains to maintain its relations with the capsule and periosteum. After this dissection has been carried as far as possible on the inner side, he lifts the tendon of the biceps from its sheath, carries it inward, drops it into the joint, and denudes the bone on the outer side with the same precautions, using the knife instead of the elevator to detach the capsule, tendons, and ligaments. The rest of the operation as above.

If only the articular head of the bone is to be resected, near the upper end of the tuberosities, there is no periosteum to be removed. The ligamentous and muscular attachments are approached from within the joint, and the bone divided with the chain or keyhole saw, without raising it from its place.

By a Transverse Incision. (Nélaton, Perrin.)—A transverse incision three and a half or four inches long is made parallel to and half an inch below the edge of the acromion, beginning in front between it and the coracoid process. The fibres of the deltoid are divided close to the acromion, and by their retraction expose the capsule largely.

The capsule is divided along the outer edge of the tendon of the biceps, and then transversely in the direction of the external wound; the bone is approached and denuded through this opening, and the operation completed as before.

The vessels and nerves are well protected by this method, but it is very difficult of execution.

Excision of the Head of the Scapula.—When the disease is confined to the glenoid cavity and the neck of the scapula, the affected parts can be removed by a longitudinal posterior incision extending from the base of the acromion to the fold of the axilla.

EXCISION OF THE ELBOW-JOINT.

Partial excision of the elbow-joint for disease, even when the portions left behind are entirely healthy, is more dangerous and gives as a rule less satisfactory results than complete excision. The humerus should be sawn through at or just above the epicondyles, the ulna at the base of the coronoid process, and the radius through its neck. The extent of the disease may make it necessary to surpass these limits, but the result will then be less perfect, and in any case every effort should be made to preserve the continuity between the periosteum and the tendons of the brachialis anticus and biceps so as to provide for future flexion of the forearm. An exception to the rule of total excision may be found in the preservation under some circumstances of all the olecranon except its articular surface; the joint thus obtained is firmer, and active extension more powerful.

Reproduction of bone takes place less completely at the elbow-joint than at any other of the major articulations, and consequently the greater the amount removed the greater the danger of the formation of an imperfect, loose, and inefficient joint, even when the subperiosteal method has been thoroughly carried out. Von Langenbeck[1] removed four and a half inches of the humerus and two inches of the ulna subperiosteally in a case of gunshot injury, and says the result was the worst he ever saw, the connection between the arm and forearm being so very loose that the patient was obliged to use a supporting brace, by the aid of which he was able nevertheless to make excellent use of his hand. Ordinarily anchylosis is to be preferred to a very loose joint.

In cases of gunshot injury Von Langenbeck and Ollier remove as little as possible, making a partial (semi-articular) excision when either the humerus or the bones of the forearm alone are injured. The English authors think the danger in cases of excision for disease is rather of removing too little than too much, and recommend that the humerus be sawn through above the condyles.

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[1] Loc. cit., p. 443.

As the joint is covered anteriorly with soft parts, among which lie nearly all the principal arteries and nerves, and is almost subcutaneous posteriorly, it must be approached from the latter side, and the incisions must be made with especial reference to the safety of the ulnar nerve, where it runs between the olecranon and the epitrochlear. The original method, and the one used almost exclusively for many years, was the H-incision, composed of two longitudinal incisions connected midway by a transverse one crossing the tip of the olecranon. It has the disadvantage of dividing the ulnar nerve or exposing it in the wound during the period of suppuration, and, having been superseded by less complicated ones, does not need to be described.

Although excellent joints have been obtained by the old operations the preference should be given to the modern subperiosteal method, not only on account of the greater certainty of the reëstablishment of a useful limb, but also because the danger of diffuse inflammation and purulent infiltration is much less when it is employed. These dangers are greater at the elbow than at any other joint, except the hip, and secondary amputation is more frequently required.

The other methods have been devised with the view of sparing the nerve, preserving the attachment of the triceps and the continuity of the lateral ligaments with the periosteum, and facilitating the operation. Although the central longitudinal incision has been extensively used the preference seems now to be due to methods of approach from the radial side, such as Ollier's, Nélaton's, and Hueter's.

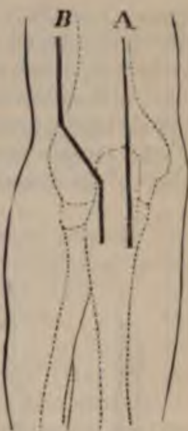
Central Longitudinal Incision. Fig. 74, *A*. (Von Langenbeck.)—The forearm being slightly flexed, a longitudinal incision 3½ inches long is made a little to the inner side of the median line of the triceps and ulna, and carried down to the bone. The inner edge of the divided periosteum is raised from the ulna, the corresponding half of the tendon of the triceps detached with it, and the dissection continued toward the internal condyle, the knife being kept constantly against the bone, and the flexion of the arm increased as the dissection advances. As the epitrochlea is approached the greatest care is needed to preserve the connection between the periosteum, the muscular attachments, and the internal lateral ligament, and it may be necessary to prolong the first incision upward so as to get more room.

After the inner half of the joint has thus been laid open and the epitrochlea bared, the soft parts are replaced and a similar dissection made upon the outer side with the same precautions.

The humerus is then dislocated backward through the wound and sawn through at, or as near as possible to, the epicondyles, according to the lesion. If the condition of the soft parts does not allow of this projection of the humerus the chain or keyhole saw must be used.

The ulna is then cleaned circularly as far as necessary and sawn through, and the head of the radius removed with the saw or cutting pliers.

FIG. 74.



Excision of the elbow-joint. *A.* Von Langenbeck. *B.* Ollier

Ollier's Method.[1] (Fig. 74, *B.*)—The forearm is slightly flexed, and an incision is commenced two inches above the tip of the olecranon on the outer side of the arm at the interstice between the triceps and supinator longus. This incision, involving the skin only, is carried downward to the epicondyle, thence downward and inward in the line of the upper border of the anconæus to the olecranon, and thence, the point of the knife touching the bone, directly downward along the inner side of the posterior aspect of the ulna for one or two inches.

The fascia is then divided in the line of the incision, and the interstice between the triceps on one side and the supinator longus, radial extensor, and anconæus on the other, followed down to the capsule and bone. The capsule is opened, and the humerus denuded on its anterior and posterior faces as far inward as possible, care being taken to maintain the relations of the muscular and ligamentary attachments.

The tendon of the triceps and the periosteum of the ulna are next detached, and in separating the former it is better to begin inside the joint at the free edge of the olecranon.

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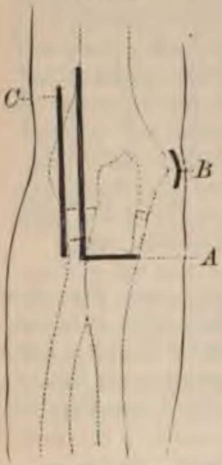
[1] Traité de la Régénération des Os, p. 340.

The denudation of the external condyle and tuberosity of the humerus is then completed, and the external lateral ligament entirely detached, the forearm flexed on its inner side, and the end of the humerus dislocated outward into the wound, thus rendering the difficult dissection of the projecting epitrochlea easier. When this latter has been completed, the periosteum of the humerus is raised circularly to the proper height, and the bone sawn through. The head of the radius is then removed, the denudation of the ulna completed, and the bone sawn through perpendicularly to its axis.

FIG. 75.



Excision of the elbow-joint. *A* Nélaton. *B*, *C*. Hueter.

Nélaton's Method. (Fig. 75, *A*.)—A longitudinal incision is begun on the outer border of the humerus between the triceps and supinator longus, 1½ inches above the end of the olecranon, and carried downwards for a distance of 3 inches. A transverse incision cutting through to the bone is next made, from the lower end of the first, across the ulna to its inner border.

The triangular flap thus formed, including the periosteum of the ulna, is dissected up, the external lateral and orbicular ligaments divided, and the head of the radius removed. The tendon of the triceps is detached and the denudation of the ulna completed.

The ulna is projected through the incision by bending the forearm toward its inner side, and is sawn off.

The humerus is then easily turned out through the incision, denuded from below upward with the usual precautions, and sawn off at the desired height.

Long Radial Incision (Hueter).[1] (Fig. 75, *B* and *C*.)—A preliminary longitudinal incision, half an inch long, is first made directly down upon the tip of the epitrochlea, or rather on its anterior side, so as more surely to avoid the ulnar nerve which lies close behind it, and the muscular attachments and the internal lateral ligament are separated by cutting around this prominence.

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[1] Deutsche Zeitschrift für Chirurgie, 2d vol., p. 68.

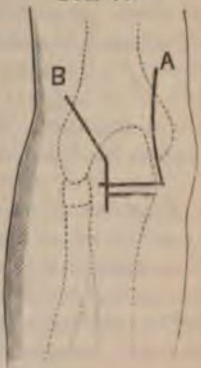
The main incision is then made by entering the knife above the point of the external epicondyle and carrying it straight down over it, thus opening the joint and exposing the head of the radius by dividing the external lateral ligament longitudinally and the orbicular ligament transversely. The head of the radius is then removed after sawing through its neck.

The operator then passes his left forefinger through the wound, first to the anterior surface of the humerus to make the capsule tense, and guide the detachment of it and the periosteum, and then along the posterior surface under the tendon of the triceps with the same object.

It is not necessary to carry this dissection very far toward the inner side, because by dislocating the ulna forcibly inward the end of the humerus can be made to project through the radial incision, and then its denudation can be easily and safely completed, and the bone sawn through.

The end of the olecranon is then brought into the centre of the incision, and the separation of the triceps begun at the upper free edge of the process with vigorous short cuts into the substance of the bone, so that it is, as it were, peeled out of its tendinous envelope. When the proper point is reached the bone is sawn through.

FIG. 76.



Osteoplastic method.
A. Von Mosetig-Moorhof.
B. By external incision.

Osteoplastic method. (Fig. 76.)—This operation, characterized by primary division of the olecranon and its reunion at the close of the operation, was proposed by Von Bruns, and was at first deemed applicable to old, irreducible, and to fresh compound dislocations. Its use has been extended to operations for foreign bodies in the joint, for anchylosis, and finally to those for fungous arthritis.

The procedure recommended by Von Mosetig-Moorhof begins by a transverse incision running from the lowest point of the external condyle across the olecranon to its inner side, thence upward alongside the olecranon to a point one inch above its tip. The ulnar nerve is then dissected out and drawn aside, and the olecranon divided with saw and chisel in the line of the first part of the incision. The flap is then drawn aside, the humerus cleared and sawn off below the epicondyles, the head of the radius removed, and the olecranon scraped and reunited with a silver suture.

I think this exposure of the ulnar nerve is unnecessary and objectionable, and have modified the operation by using the lower two-thirds of Ollier's incision and making a second transverse one from the lower end of the first across the base of the olecranon, and sawing the latter through in this line, but somewhat obliquely from below upward, into the joint. The joint was then further opened through the lateral incision, the external condyle denuded, and the flap, including the upper part of the olecranon, turned upward and inward. This exposed the joint freely, and the humerus was then readily denuded and sawn off through the epicondyles. The radius was then protruded and sawn through at the neck, the olecranon thoroughly scraped, removing most of the coronoid process, and the capsule dissected out. As the scraping of the olecranon had left its sigmoid cavity much too large, I removed a slice one centimetre thick along the line of its original section to shorten it, and then wired the pieces together. The result was very good, and active extension more powerful than in any other case I have seen.

Bilateral Incisions.—Vogt[1] speaks highly of a method by which he accomplishes the same result without division of the olecranon. His incision begins above the external condyle and is carried well below the head of the radius, dividing the orbicular ligament; then he removes the periosteum from the radius and divides it with saw or chisel just above its tuberosity, draws aside the edges of the wound, and explores the joint. If it is extensively diseased he makes a second incision on the inner side beginning above and a little behind the epitrochlea and extending about three inches downward, then with a chisel cuts away the attachments of the extensor and flexor muscles from the condyles, leaving a shell of bone attached to them, draws aside the soft parts, divides the capsule, raises the periosteum from the humerus, and saws off the end of the latter. Then, if necessary, he scrapes away the surface of the olecranon.

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[1] Centralblatt für Chirurgie, 1882, p. 555.

Partial Excision.—Ollier's and Hueter's methods are especially applicable to that form of semiarticular excision in which only the lower end of the humerus is resected. Nélaton's or Von Langenbeck's, or the lower part of Ollier's, can be used for the removal of the ends of the ulna and radius.

EXCISION OF ANCHYLOSED ELBOW.

When there is anchylosis of the joint, Von Langenbeck's incision can be used, and the ulna divided with a chain-saw after it has been denuded. The detachment of the capsule and periosteum is then proceeded with upward, and the lower end of the humerus, with the attached ends of the bones of the forearm, projected through the wound and sawn off.

Or the osteoplastic or either of the two following methods may be employed.

Excision of Anchylosed Elbow (Ollier).—An incision two and a half inches long is first made on the outer and posterior side of the limb and carried through to the bone, its centre being on a level with the tip of the olecranon. A second incision one and a half inches long, involving the skin only, is made on the inner side of the ulnar nerve at the level of the internal border of the humerus. The nerve is found on dividing the fascia, is drawn aside together with the posterior lip of the wound with a blunt hook, and is then entirely out of the way of injury.

The lips of the two wounds are separated, the periosteum detached, a narrow saw passed under the triceps, and the humerus sawn nearly through from behind forward, leaving a thin shell of bone in front which is then broken. The conditions are now those of a movable joint, and more or less of the lower fragment or of each fragment is removed, according to the condition of the bone. The triceps should be detached before the olecranon is divided.

Excision of Anchylosed Elbow (P. Heron Watson[1]).—This method is intended only for the removal of the articular end of the humerus, in cases of more or less complete anchylosis following injury. The advantages claimed for it are that it leaves the attachments of the triceps and brachialis anticus undisturbed, and limits the area of the operation almost exclusively to within the capsular ligament, and thereby seems to secure a more speedy healing of the wound. Watson has used it in six cases, in all of which the results were satisfactory.

1. A linear incision is made over the ulnar nerve at the inner side of the olecranon. 2. The nerve is carefully turned over the inner condyle. 3. A probe-pointed bistoury is introduced into the elbow-joint in front of the humerus and then behind that bone, and carried upward so as to divide the upper capsular attachments in front and behind. 4. A pair of bone forceps are next employed to cut off the entire inner condyle and trochlea of the humerus [from above downward], and then introduced in the opposite direction [from below upward and outward] so as to detach the external condyle and capitulum of the humerus from the shaft. 5. The angular end of the humerus is turned out through the incision and sawn off square. 6. The external condyle and capitulum are removed partly by twisting, partly by dissection, without any division of the skin on the outer side of the arm.

If there is dense osseous union that cannot be overcome by flexion and extension under chloroform, the humerus must be divided through the condyle with bone pliers, and the operation completed as above.

EXCISION OF THE WRIST.

In 1863 Prof. Lister was called upon to treat a case of compound fracture and dislocation of the wrist in a youth of seventeen, in which the ends of the bones of the forearm projected one and a half inches through a wound on the palmar aspect. He resected the ends of the bones and replaced the parts; five months afterward the injured wrist was as useful and as freely movable as the other, although considerably smaller. Other surgeons had had a similar experience and had reported it,[1] but to Prof. Lister belongs the credit of detecting the principle involved and of establishing upon it a new and highly successful method of operation, one which has practically superseded all others. He has not formulated the treatment of traumatic cases, but in excision for chronic disease he advises the removal of all the carpal bones, except possibly the pisiform and the hook-like process of the unciform, and of the articular surfaces of those of the metacarpus and forearm if the bones themselves are not more than superficially affected; if on examination they prove to be more deeply involved, he uses the cutting pliers and gouge freely. In one instance he hollowed out the entire shaft of the third metacarpal bone, leaving it a mere shell, and the case did well. In his earlier operations he divided the radius and ulna transversely about an inch above the joint, but as these bones are usually affected but slightly, he now removes only a thin slice from the end of the radius, and cuts through the ulna obliquely, so as to take away all the part that is covered with cartilage and leave the styloid process (Fig. 77).

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[1] Edinburgh Med. Journ., May, 1873, p. 986.

The principles involved in the treatment of traumatic cases, especially after gunshot injury, are not yet well established. Von Langenbeck[2] inclines toward primary excision whenever the injury is severe, and thinks it may safely be partial instead of complete. The exuberant growth of bone which characterizes this locality occurs during conservative treatment as well as after excision, and its interference with the function of the member is likely to be even greater in the former than in the latter case.

Posteriorly and laterally the wrist is covered only with skin and tendons, with no arteries or nerves of importance except the radial artery, which winds around the outer side to pass again through the first metacarpal space to the palmar aspect of the hand, and form the deep palmar arch just below the bases of the metacarpal bones. Between the extensor tendons of the thumb and of the forefinger exists a triangular interval, shown in figure 78, the apex of which is directed upward and lies near the middle of the dorsal aspect of the epiphysis of the radius. Within this space are found only the tendons of the long and short extensores carpi radiales, with their insertions into the second and third metacarpals, and as experience has shown that these tendons can be detached or divided without prejudice to the subsequent usefulness of the hand, the articulation can be safely approached through this space.

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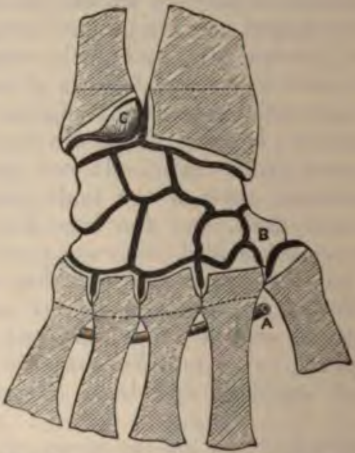
[1] Just: De resect. epiphys. cum decap. radii exemplo., Leipzig, 1840. Verbeeck, Bull. de l'Acad de Méd. de Belgique, vol. iii.

[2] Langenbeck's Archiv, vol. xvi.

FIG. 77.

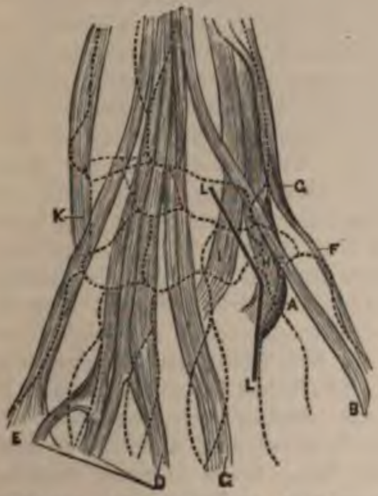


Excision of the wrist, Lister. *A.* Deep palmar arch *B.* Trapezium. *C* Articular surface of ulna. The dotted lines include the amount removed in the earlier operation; the unshaded portions represent those removed when the disease is limited to the carpus.

The extensor tendons are lodged in deep grooves upon the surface of the radius, from which it is very difficult to raise them without opening their sheaths, and therefore if it is necessary to take more than a thin slice from the bevelled end of the bone, it should be done with a gouge and as a late step in the operation. In this way it is possible to leave the tendons unhurt, and even unseen.

On the inner side the tendon of the extensor carpi ulnaris covers the ulna, in front of it passes the flexor carpi ulnaris on its way to its insertion into the pisiform bone and the base of the fifth metacarpal. The anterior aspect is occupied by the numerous and important flexor tendons, the median and ulnar nerves, and several arteries or arterial branches of considerable size. Toward the outer side the tendon of the flexor carpi radialis passes through a groove on the surface of the trapezium, to be attached beyond the base of the second metacarpal. An ulnar incision should pass between the flexor and extensor carpi ulnaris at the anterior border of the ulna.

FIG. 78.



Excision of the wrist, Lister. *A.* The radial artery. *B.* Extensor secundi internodii pollicis. *D.* Ext. comm. digitorum. *E.* Ext. min. dig. *F.* Ext. prim. int. pol. *G.* Ext. oss. met. poll. *H. I.* Ext. carp. rad. long. and brev. *K.* Ext. carp. uln. *L, L.* Line of radial incision.

Bilateral Incisions (Lister[1]). Figs. 78 and 79, *A*, *B*.—All adhesions are first broken down by freely moving all the articulations of the hand. The radial incision is made in the situation indicated by the line *L L* in Fig. 78, or Fig. 79, *A*. It commences above at the middle of the dorsal aspect of the radius on a level with the styloid process. Thence it is at first directed toward the inner side of the metacarpo-phalangeal articulation of the thumb, running parallel to the tendon of the extensor secundi internodii; on reaching the radial border of the second metacarpal bone it is carried downward longitudinally for half the length of the bone.

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[1] Lancet, 1865, p. 335, slightly abridged.

The soft parts on the radial side of the incision are next detached from the bones with the knife guarded by the thumb-nail, so as to divide the tendon of the extensor carpi radialis longior at its insertion into the base of the second metacarpal, and raise it along with that of the extensor brevior, previously cut across, and the extensor secundi internodii, while the radial artery is thrust somewhat outward. The trapezium is then separated from the rest of the carpus by means of cutting forceps applied in a line with the longitudinal part of the incision. The removal of the trapezium is reserved till the rest of the carpus has been taken away. The soft parts on the ulnar side of the incision are now dissected up as far as is convenient, the extensor tendons being relaxed by bending back the head.

The knife is next entered on the inner side of the arm, two inches above the end of the ulna, immediately anterior to the bone, and is carried downward between it and the flexor carpi ulnaris, and on in a straight line as far as to the middle of the fifth metacarpal bone at its palmar aspect (Fig. 79, *B*). The dorsal lip of the incision is raised, and the tendon of the extensor carpi ulnaris cut at its insertion into the fifth metacarpal, and dissected up from its groove in the ulna, care being taken to avoid isolating it from the integuments, and thus endangering its vitality. The extensors of the finger are then readily separated from the carpus, and the dorsal and internal ligaments divided, but the connections of the tendons with the radius are purposely left undisturbed.

The anterior surface of the ulna is then cleared by cutting toward the bone, so as to avoid the artery and nerve; the articulation of the pisiform is opened, if that has not been already done in making the incision, and the flexor tendons are separated from the carpus. While this is being done the knife is arrested by the process of the unciform bone which is clipped through at its base with pliers. The knife must not be carried further down the hand than the bases of the metacarpal bones, so as not to injure the deep palmar arch. The anterior ligament of the wrist-joint is divided, after which the junction between the carpus and metacarpus is severed with cutting pliers, and the carpus extracted through the ulnar incision by seizing it with strong forceps and touching with the knife any ligamentous connections that may remain undivided.

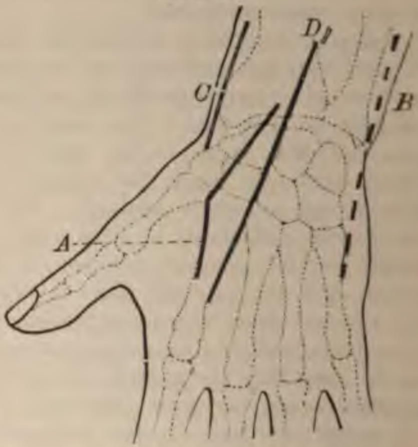
The hand being now forcibly everted the articular ends of the radius and ulna will protrude at the ulnar incision. If they appear sound or only superficially affected, the articular surfaces only are removed. The ulna is divided obliquely with a small saw, so as to take away the cartilage-covered rounded part over which the radius sweeps, while the base of the styloid process is retained. The end of the radius is then cleared sufficiently to allow a thin slice to be sawn off parallel to the general direction of the inferior articular surface, and the articular facet on the ulnar side of the bone is clipped away with bone forceps. If, on the other hand, the bones prove to be deeply carious, the pliers or gouge must be used with the greatest freedom.

The metacarpal bones are next dealt with on the same principle. If sound only the articular surfaces are clipped off.

The trapezium is next seized with forceps and dissected out, so as to avoid cutting the tendon of the flexor carpi radialis which is firmly bound into the groove on its palmar aspect, the knife being also kept close to the bone elsewhere to preserve the radial artery. The articular end of the first metacarpal is then removed. Lastly, the articular surface of the pisiform is clipped off, the rest of the bone being left if sound. The process of the unciform is also left if sound. The radial wound may be closed with sutures, but the ulnar one must be kept open for drainage, and the limb must be bound upon a splint in such manner that while the wrist is firmly fixed passive motion can be given regularly to the fingers.

Radial Incision (Ollier). Fig. 79, *C.*—An incision involving only the skin is begun on the outer side of the wrist, an inch below the styloid process of the radius, and carried upward along the outer border of the bone for a greater or less distance, according to the amount to be removed. A cutaneous branch of the radial nerve is exposed and drawn aside, the fascia divided, and the extensor tendons of the thumb recognized. These tendons are a guide which is easily found. They are superficial, and contained in a separate groove. On opening the sheath and drawing them aside, the insertion of the supinator longus is exposed, on the outer side of which, and parallel to the tendon, the periosteum of the radius must then be divided.

FIG. 79.



Excision of the wrist. *A.* Lister's radial incision. *B.* Lister's ulnar incision. *C.* Ollier. *D.* Von Langenbeck.

Using a straight, sharp elevator, the surgeon next detaches the tendon of the supinator, preserving its relations with the periosteum, and then denudes the lower end of the radius inward, removing periosteum and capsule. Then, bending the hand forcibly toward its inner side, he separates the remaining fibrous attachments and dislocates the lower end of the radius outward. The ulna can be protruded through the same wound and denuded from below upward, but it is better to make a longitudinal incision on the inner side for this purpose.

The ends of the radius and ulna are then sawn off, and through the gap thus left the carpal bones are successively removed with gouge and forceps.

Dorso-radial Incision (Von Langenbeck). Fig. 79, *D.* —The hand is bent toward the inner side, and an incision is begun at the ulnar border of the second metacarpal bone near its middle and carried upward four inches, crossing the ulnar edge of the tendon of the extensor carpi radialis brevior, where it is inserted into the base of the third metacarpal bone, and splitting the dorsal ligament of the wrist exactly between the tendons of the extensor secundi internodii and extensor of the forefinger. This incision should be carried down to the bone, and the soft parts detached on the radial side with an elevator; the tendons, where they lie in the grooves, are raised bodily with the periosteum, and their sheaths are not opened.

The hand is flexed so as to make the first row of carpal bones present in the wound; the scaphoid is separated from the trapezium and taken out, and followed in turn by the semilunar and cuneiform, the interosseous ligaments being cut and the bones pried out with a small elevator. The trapezium and pisiform are left if possible.

To take out the second row, the operator steadies the round articular end of the os magnum with the fingers of his left hand, and, while an assistant abducts the thumb, he divides with a knife the connection between the trapezium and trapezoid, passes the knife into the carpo-metacarpal joint, and cuts the ligaments on the dorsal side of the ends of the metacarpal bones while an aid flexes them. In this way the trapezoid, magnum, and unciform can be brought out together.

The lateral ligaments are then carefully separated from the radius and ulna, the bones protruded and sawn through.

EXCISION OF THE HIP-JOINT.

In this joint, as in the shoulder, the disease is often confined to the head of the bone, and under such circumstances partial excision should be performed. When the acetabulum is diseased the loose pieces must be picked out, and the gouge applied to the roughened surface. The line of section of the femur should pass below the great trochanter, however limited the disease may be, for if this process is left it is liable to protrude through the wound and obstruct the escape of the secretions. If the disease extends beyond this point additional slices must be removed, or the gouge used until healthy bone is reached.

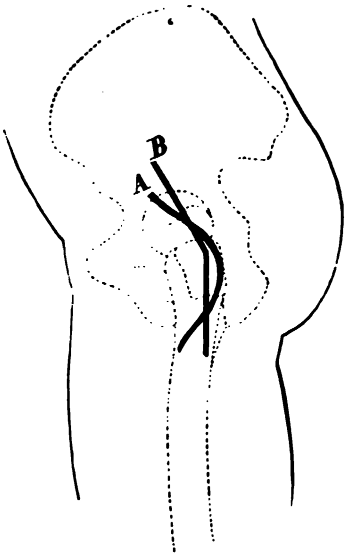
The anatomical disposition of the parts is such that the joint is best approached from the outer and posterior aspect, the incision passing over the top of the great trochanter. Different surgeons have inclined the upper part of the incision forward and backward at various angles, or have dissected up a triangular flap, its apex directed sometimes upward, sometimes downward.

Sayre's Method. (Fig. 80, *A.*)—Enter the point of the knife midway between the anterior superior spine of the ilium and the top of the great trochanter, and drive it down to the bone; then, keeping it firmly in contact with the bone, draw it in a curved line to the top of the trochanter, midway between its centre and posterior border, thence forward and inward, making the whole length of the incision from four to eight inches, according to the size of the thigh. Make sure that the periosteum is divided throughout.

Then, drawing aside the soft parts, divide the periosteum transversely just opposite to, or a little above, the lesser trochanter, carrying the division as far as possible around the bone. Beginning at the angle formed by the two incisions, raise the periosteum on each side, together with its membranous attachment, as far as the digital fossa. Then, substituting a knife for the periosteal elevator, divide the insertions of the muscles at this point, keeping close to the bone, and afterward separate the remaining periosteum as far as can be done without tearing it. Then adduct the leg slightly and raise the head of the femur gently out of the acetabulum; this will detach the last of the periosteum, and allow the finger to be passed around the bone as a guide for the saw, which should be applied just above the lesser trochanter.

If the bone cannot be readily dislocated saw it through first, and then remove the head with the forceps or elevator.

FIG. 80.



Excision of the hip. *A.* Sayre. *B.* Ollier.

If the acetabulum is perforated the edges must be chipped off very carefully down to the point at which the periosteum on the pelvic side is still adherent.

Ollier's Method. (Fig. 80, *B*.)—Ollier makes a somewhat similar incision. It begins four finger-breadths below the crest of the ilium, and the same distance behind the anterior superior spine, runs downward to the most prominent part of the great trochanter, and thence directly down the shaft of the femur. Its upper part should involve the skin and fascia only. The posterior lip, including the glutæus maximus, is drawn back, exposing the glutæus medius, the fibres of which are then separated without cutting them. This permits the attachments of the glutæus medius to be preserved, and the glutæus minimus can be exposed by drawing apart the edges of the opening made in the other, and then divided in the same manner or drawn forward with a blunt hook.

The capsule is split from the edge of the cotyloid cavity to the digital fossa, and detached together with the tendinous insertions. The head of the femur is dislocated backward, the ligamentum teres divided, and the denudation continued downward to the lesser trochanter. The bone is then protruded and sawn off with a chain or common saw.

Anterior Incision.—Roser recommends, in order to preserve the trochanter, an anterior incision in the line of the neck of the femur, beginning just outside the crural nerve, and dividing the iliacus, rectus, sartorius, and tensor vaginæ femoris. The capsule is divided in the same line, the head turned forward into the wound by rotating the thigh outward, and sawn off.

Lücke and Schede have modified this by making the incision vertical instead of transverse, beginning outside the crural nerve a little below and to the inner side of the anterior superior spine of the ilium, and running directly downward. The inner borders of the sartorius and rectus are exposed and drawn outward, and then the outer border of the psoas-iliacus exposed and drawn inward. Then the thigh is flexed, abducted, and rotated outward, and the capsule divided.

ANCHYLOSIS OF THE HIP-JOINT.[1]

When the anchylosis is not associated with the loss of a great part of the head and neck of the femur, that is, when it follows inflammation of the joint due to rheumatism, pyæmia, traumatism, or chronic disease that has been arrested at an early stage, Mr. Adams's operation of subcutaneous division of the neck of the femur may be applicable, but usually division below one or both of the trochanters, or excision of the head and neck, is to be preferred.

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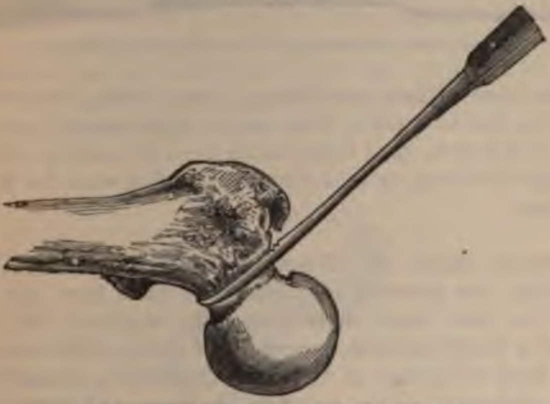
[1] This subject, which properly belongs under osteotomy, is placed here on account of its intimate relations with excision of the joint.

Division below the lesser trochanter is only undertaken to remedy a faulty position of the limb, for there can be no question of establishing a new joint below the insertion of the psoas and iliacus. It is doubtful also if a permanently movable joint can be obtained by division at a higher point; it certainly cannot unless a portion of the bone is removed, and probably not even then, for the tendency of the cut ends to unite after a time is very great.

FIG. 81.



Subcutaneous division of the neck of the femur.

Subcutaneous Division of the Neck of the Femur (Adams[1]).—The only special instrument needed is a saw somewhat resembling a tenotomy knife, the cutting part being one and a half inches long and three-eighths of an inch wide, and the shank about two and a half inches long. (Fig. 82.)

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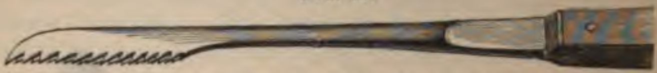
[1] A new operation for bony anchylosis of the hip-joint with malposition of the limb, by subcutaneous division of the neck of the thigh bone, by William Adams. London, 1871. Reprinted from the *British Medical Journal* for December 24, 1870.

A tenotomy knife is entered a little above the top of the great trochanter and pushed straight into the neck of the femur, dividing the muscles and opening the capsule freely. The soft parts being fixed by the thumb and fingers of the left hand, the knife is withdrawn and the saw passed promptly down to the bone through the track made by it.

FIG. 82.



Adams's saw for subcutaneous division of the neck of the femur.

The bone is then sawn through from before backward, so that the line of section shall be at right angles to the long axis of the neck, care being taken to avoid cutting obliquely through the neck, or in a direction parallel with the shaft of the bone.

Division below the Trochanter.—This operation, often including the removal of a wedge of bone from the outer side, has been much more frequently employed for the relief of a faulty position, especially of flexion and adduction. One great advantage is that in it the bone is divided below the attachment of the anterior ligament and capsule, the retraction of which maintains the faulty position. The objection to it, because of which some prefer to excise the joint, is that it only substitutes one fixed position for another.

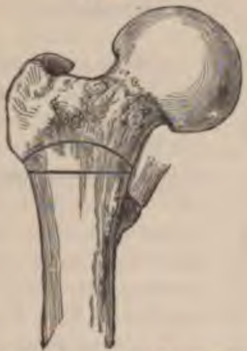
Operation.—The trochanter is exposed by a longitudinal incision on its outer, posterior aspect, the peritoneum divided and raised in front and behind, and a wedge of bone removed by chiseling while the limb rests on a sandbag, or with the exsector or saw.

Excision.—Posterior incision as above described, with such modifications as may be made necessary by dislocation; division of the neck with the saw, if possible, otherwise with the chisel; then removal of the head, or what remains of it by chiseling.

The upper end of the bone is then lodged in the acetabulum, after subcutaneous division of such muscles and soft parts as interfere and removal of the upper part of the trochanter, if necessary. Extension by weight and pulley must be kept up for a long time.

Operation for Establishment of a False Joint (Sayre).—A longitudinal incision six inches in length is made over the great trochanter, commencing just above its crest and as near as possible to its centre, and carried directly down to the bone. A transverse incision is then made through the skin and fascia only at the centre of the posterior lip of the first. The anterior surface of the bone is next cleaned with an elevator until the trochanter minor can be felt with the finger, the posterior surface similarly treated, and the chain-saw passed just above this process.

FIG. 83.



Lines of section in Sayre's operation for anchylosis of hip-joint.

A curved section of the bone is made by sawing first upward and outward, then outward, and finally outward and downward. The saw is passed a second time around the bone, and the lower fragment divided transversely one-eighth of an inch below the beginning of the first line of section. (Fig. 83.) The portion of bone thus removed is about three-fourths of an inch thick at its thickest part.

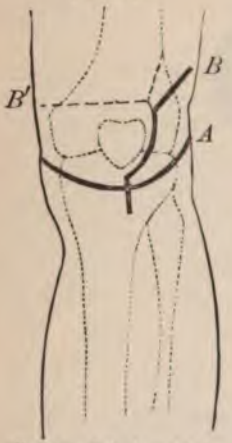
Probably two parallel sections one-half or three-quarters of an inch apart would answer equally well.

EXCISION OF THE KNEE-JOINT.

This should always be complete to this extent, that a slice should be taken from each bone, but it is not always necessary to remove the entire articular surface of the femur. In children the amount removed should be as small as is consistent with removal of all that is diseased. It is recommended by Spence and some others that the patella should be retained if not diseased, but experience has shown this to be unwise, for it does not add materially to the strength of the subsequent union, and the bone itself is likely to become carious.

As anchylosis should always be aimed at, the incision may cross the front of the joint and divide the ligamentum patellæ or the patella. Some surgeons provide for drainage by making a dependent opening in the popliteal space, but this seems to be unnecessary.

Fig. 84.



Excision of the knee-joint.
A. Semilunar incision.
B. Ollier's incision.

Semilunar Incision. (Fig. 84, *A*.)—The knife is entered on one side of the limb at the posterior part of the condyle, and carried across midway between the patella and the tuberosity of the tibia to a corresponding point upon the other side. This incision should extend down to the bone throughout, dividing the ligamentum patellæ. The flap is reflected, the crucial ligaments divided close to their attachment to the tibia, the lateral ligaments divided, the end of the femur cleared as far as may be necessary, with especial care for the safety of the popliteal vessels, protruded through the wound, and sawn off at the point indicated in Figs. 85 and 86. The line of section must be parallel to the line of the articulation, not at a right angle to the axis of the shaft, for that is directed inward and downward. If necessary, additional slices of the bone are removed, or the gouge is used. All the articular cartilage should be removed.

The end of the tibia is next projected, cleaned, and sawn off about half an inch below its upper surface.

In sawing the bones it is best not to make a complete section with the saw, but to stop a little short of the posterior surface and complete the separation by fracturing what is left.

Finally, the patella is taken out, and diseased portions of the synovial membrane scraped or clipped off.

Transverse Incision.—The incision should cross the patella at or just below its centre and extend beyond the centre of the condyle on each side; at each end should be made a longitudinal incision extending two inches above, and one inch below the transverse one. The remainder of the operation is the same as the preceding.

Ollier's Subperiosteal Method. (Fig. 84, *B.*)—An incision is begun two inches above and to the outer side of the patella, and carried down to the upper and outer angle of that bone, thence along its outer edge and that of the ligamentum patellæ to and beyond the tuberosity of the tibia. If the subject is exceptionally muscular, or the internal condyle very prominent, the incision should be begun nearer the median line (Fig. 84, *B′*). The knife should penetrate to the bone throughout, and open the capsule of the joint.

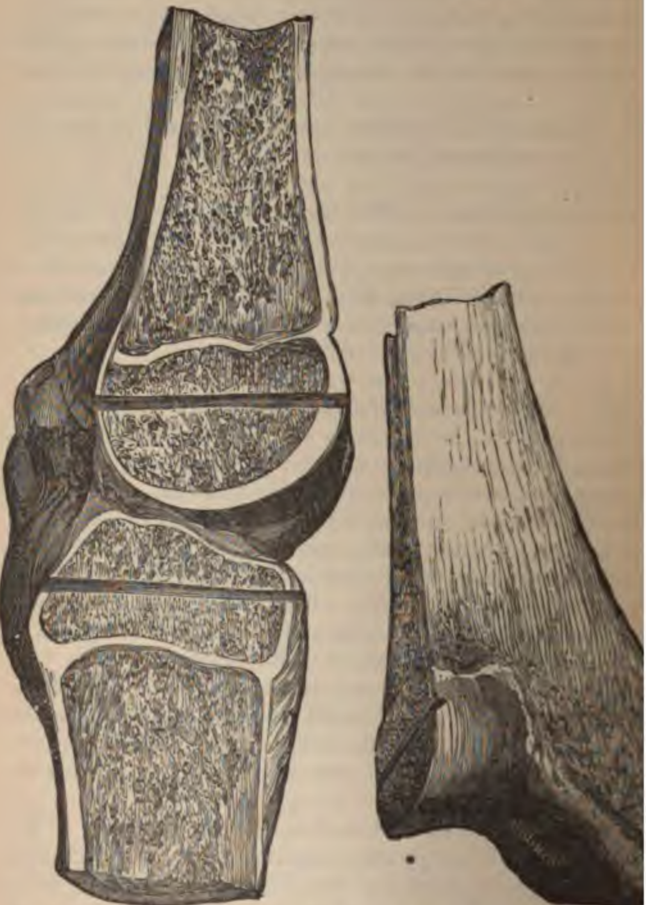
The periosteum of the outer condyle of the femur with the attachments of the external lateral ligaments and external gastrocnemius is next detached, and then the anterior surface of the femur cleared. The crucial ligaments are cut, and the patella carried over the internal condyle with the aid of blunt hooks.

The leg is then bent backward and inward, the end of the femur protruded through the wound, cleared posteriorly, and sawn off. The upper end of the tibia is then cleared from above downward, as far as may be necessary, and a slice taken off.

If the patella is diseased he removes it, leaving the periosteum that covers its anterior surface.

Extirpation of the Knee-joint.—This term has given to the systematic removal of the synovial membr

FIG. 85. FIG. 86.



Sections to show the position of the epiphyseal cartilage at the knee and the which the section ought to be made in excision.

The incision may be the transverse or the semilunar described. After the joint has been opened, the patella, its upper half, is drawn downward, the soft parts dissected from in front of it, the tendon of the quadriceps divided obliquely upward until the fibrous synovial sac is reached, and then the latter drawn down and dissected away from the adjoining soft parts and the bone. The lower portion is removed in like manner, together with the semilunar cartilages, and then, after division of the lateral and crucial ligaments, the posterior portion of the sac. This latter part of the operation may be facilitated by first sawing off the bone that is to be removed. Volkmann[1] strongly advises that the articular surfaces should be spared unless actually diseased, and that the interference with the bone should be restricted to gouging out tuberculous foci.

EXCISION OF THE ANKLE-JOINT.

The results of excision of the ankle-joint have been, on the whole, so unfavorable that the English and German surgeons are inclined to abandon it entirely. When the operation has been undertaken on account of caries, the disease has usually returned in the tarsal bones, and rendered secondary amputation necessary. When, on the other hand, it has been performed on account of injury, the mortality has been great, secondary amputation has been frequently required, and the position of the foot in the cases that recovered has usually been faulty.

The results of conservative expectant treatment have been no better, and, in part, for the same reasons. In correspondence, as has been pointed out, with the late consolidation of the epiphysis, inflammation of this extremity is likely to be severe, and its destructive results extensive; the reproduction of bone is also very abundant and leads almost necessarily to anchylosis, so that, unless great attention is given to maintaining the foot in a proper position during the whole period of treatment, it will unite at a faulty angle with inversion or eversion of the sole, and inability to support the weight of the body.

As anchylosis is to be expected, the rule in excision is to remove the smallest possible amount of bone, and to make partial instead of complete excision when the disease does not extend to the whole joint. The retention of one or the other malleolus is a great help in preventing shortening, and in the use of a plaster splint. The interosseous membrane between the tibia and fibula must be preserved carefully. It not only has a great tendency to ossify, but also seems to favor the reproduction of bone.

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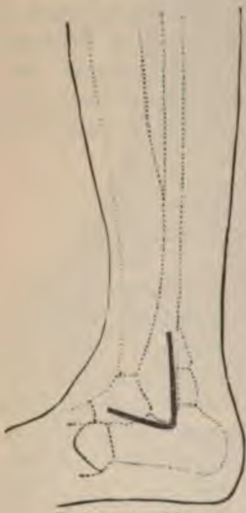
[1] Centralblatt für Chirurgie, 1885, p. 139.

FIG. 87



Excision of ankle.

Operation (total excision).—An incision involving only the skin is begun two inches above the external malleolus and a little behind the middle of the fibula, carried directly down to the end of the bone, and thence forward and slightly upward toward the instep for an inch (Fig. 87). The periosteum covering the fibula is divided throughout and dissected up from the bone with the attachment of the lateral ligaments, especial care being taken not to open the sheath of the peroneal muscles at the posterior border of the malleolus, and to remove all the thick periosteum and the interosseous membrane on the inner side. If necessary, a transverse liberating incision may be made through the periosteum at the upper end of the cut. The bone is then divided with a keyhole or chain saw, the upper end of the lower fragment drawn out of the wound to expose and facilitate the separation of the remaining attachments, and the piece removed.

The soft parts are then held out of the way with retractors, and the upper articular surface of the astragalus sawn off with the keyhole saw, but not removed.

The foot is next turned upon its outer side, and a longitudinal incision two or three inches long made along the side of the tibia, ending half an inch below the tip of the malleolus, where it is then crossed by a short horizontal one involving the skin only. The periosteum of the tibia is divided in the line of the incision and transversely at its upper end, and dissected off, the bone sawn through, and the piece removed. Langenbeck makes the line of section oblique downward and outward, because it is easier to do so, but most surgeons prefer to have it transverse. The upper part of the astragalus, which has been previously sawn off, is then removed through the same incision.

The gouge is used to scrape away any diseased parts found on the cut surface of the astragalus, or the bone may be seized with strong forceps and dissected out entirely.

If the injury has affected the astragalus only (as in some gunshot wounds), its splinters are best removed through a longitudinal incision upon the dorsum of the foot between the extensor tendons of the first and second toes.

Vogt's Method, by Removal of the Astragalus.—A serious objection to the use of the preceding operation in cases of tuberculous disease lies in its insufficient exposure of the interior of the joint to view and it has been proposed by Hueter to return to the old method of an anterior transverse incision with division of all the extensor tendons, and by Busch to open the joint by cutting across the sole and sawing through the calcaneum. Vogt,[1] however, has recently proposed and employed another method which avoids this extensive division of the soft parts and which enables the surgeon to explore the joints thoroughly and, if necessary, to excise the synovial membrane. It consists in primary methodical extirpation of the astragalus without resection of the malleolus.

Operation.—A longitudinal incision on the outer side of the extensor tendons, three or four inches long, beginning above between the tibia and fibula, and ending below at the line of the calcaneo-cuboid joint; after division of the fascia the tendons are raised in their sheaths, carefully separated from the underlying parts, and strongly retracted to the inner side. The extensor brevis is then cut, the outer side of the incision retracted, the capsule split longitudinally to its full extent and separated on both sides from the bone with knife and elevator, the head and neck of the astragalus cleared, and the astragalo-scaphoid ligament divided.

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[1] Centralblatt für Chirurgie, 1883, p. 289.

A second incision is made from a point somewhat below the centre of the first backward below the external malleolus, dividing everything down to the astragalus, but sparing the peroneal tendons. The foot is then supinated, the anterior ligaments cut away from the external malleolus, and the strong interosseous ligament divided by thrusting a small strong knife into the groove between the astragalus and calcaneum. The head of the astragalus is then drawn forcibly outward with a stout hook, while the foot is supinated, the deep portion of the internal lateral ligament cut by passing a knife between the malleolus and the astragalus, the latter drawn forward into the incision, and its posterior attachments cut.

The remainder of the operation will vary with the extent and character of the disease. All the adjoining bones are freely exposed to inspection, and can be scraped, gouged out, or sawn off.

I have found the execution of this operation easy, even when the capsule was much thickened by disease, and its exposure of the interior of the joint is very satisfactory.

OSTEOPLASTIC EXCISION OF THE FOOT (HEEL AND ANKLE) (MIKULICZ).

This ingenious operation, the results of which have proved very satisfactory, was introduced by Mikulicz in 1881.[1] It is specially applicable to cases in which the integument about the heel has been extensively destroyed.

Operation. (Fig. 88.)—Abdominal decubitus. An incision beginning a little in front of the tubercle of the scaphoid is carried directly across the sole of the foot to a point just behind the base of the fifth metatarsal bone. From each end of this one another incision is carried backward and upward to the base of the corresponding malleolus, and the upper ends of the last two incisions are then united by a fourth which passes horizontally across and divides the tendo Achillis. In all the incisions the knife is made to touch the bone throughout.

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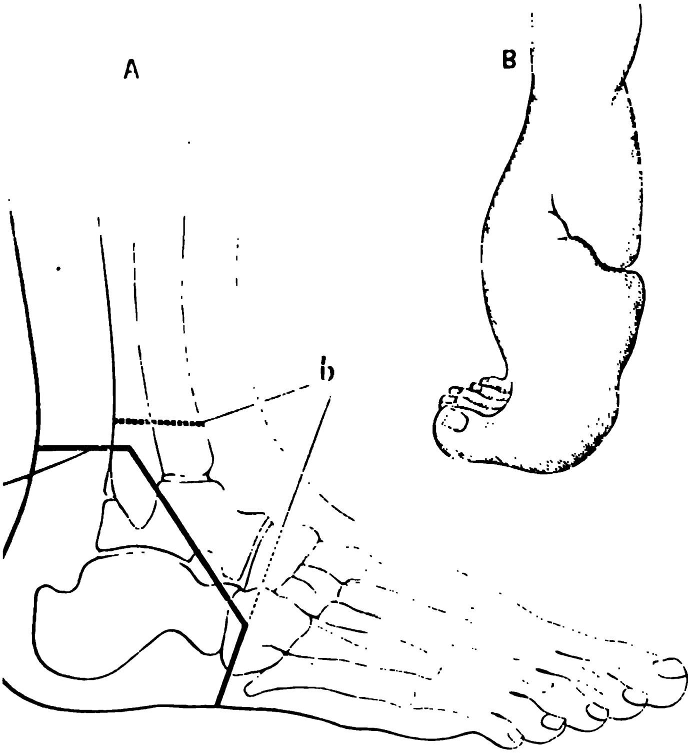
[1] Archiv für Klinische Chirurgie, vol. 26, p. 191.

The lateral ligaments of the ankle are next divided, the joint opened from behind, and the calcaneum and astragalus carefully dissected from the tissues in front of the incisions and removed by disarticulating at the medio-tarsal joint.

FIG. 88.



Osteoplastic excision of the foot. (Mikulicz.)

Finally, the malleoli and lower articular surface of the tibia and the posterior portion of the cuboid and scaphoid are sawn off as shown by the dotted lines in the figure, the cut being made from behind forward.

The cut surfaces of bone are then brought into apposition, and fastened together with nails or sutures, and the wound closed. Fig. 88, B. represents the result.

EXCISION OF THE BONES AND SMALLER ARTICULATIONS.

EXCISION OF THE SUPERIOR MAXILLA.

This operation may be required on account of malignant tumors of the bone or antrum, or of suppurative osteitis and necrosis, or to give access to the base of implantation of a naso-pharyngeal polyp. In the first case the periosteum should not be retained; in the second its separation from the bone is in great part accomplished by the inflammatory process; in the third it should be carefully retained so as to diminish the subsequent deformity.

In total excision the bony connections that require to be divided are: (1) The one with the malar bone below the outer angle of the orbit. (2) That with the opposite bone along the centre of the hard palate. (3) Those formed by the nasal process near the inner angle of the orbit; and (4) that with the palate bone and pterygoid process of the sphenoid. The first may be divided by nicking the anterior surface of the bone with a saw, and completing the division with cutting forceps, or with chisel and mallet, or by passing a chain-saw around it, through the spheno-maxillary fissure in the orbit and zygomatic fossa. The second is divided, after having drawn one or both incisor teeth, by means of a saw passed into the nostril, or with cutting forceps with long narrow blades, or a chisel. The third is easily divided with forceps or a chisel, and the fourth by twisting the bone downward after all the other connections have been severed.

The periosteum, covering the floor of the orbit, is thick and easily detached; that on the hard palate is thick and difficult of removal, on account of the irregularities of the surface. There is but little danger of injury to the internal maxillary artery, and it is seldom necessary to apply more than one or two ligatures to its divided branches. Oozing is arrested by packing with antiseptic gauze.

In partial excision the orbital plate is left, the line of division of the bone passing through the anterior wall of the antrum from the nostril to the lower corner of the union with the malar bone. The remaining attachments are then broken as before. There are also other varieties of partial excision for the removal of naso-pharyngeal polypi; removal of the nasal process with the nasal bone; removal of part of the hard palate (Nélaton); and temporary removal of different portions, preserving the connection with the soft parts, and replacing them after the polyp has been removed.

The incisions that have been proposed may be classed as (1) external and (2) median; the former extending from the angle of the mouth upward and outward to the malar bone; the latter passing from or near the middle of the lip up toward the inner angle of the eye. The former are open to the objections that they divide the branches of the facial nerve, endanger Steno's duct, and leave a conspicuous scar. The preference is now generally accorded to the median incisions. These follow the outline of the side of the nose more or less closely, and some of them are supplemented by a transverse incision, passing a quarter of an inch below the lower margin of the orbit. For partial excision Guérin recommends an incision passing from the side of the wing of the nose along the naso-labial fold to the angle of the mouth (Figs. 89 and 90).

In order to avoid the swallowing of blood, it is well not to carry the incision through the lip or divide the gingivo-labial fold until after the anterior face of the bone has been denuded as far as possible.

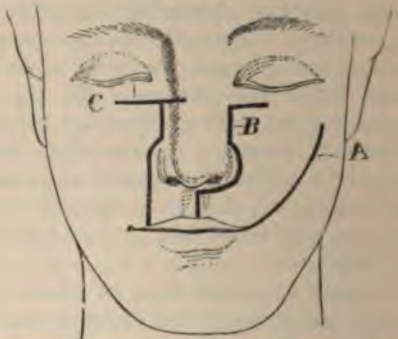
It is possible to remove the superior maxilla through the mouth without making any cutaneous incisions, but it is a very difficult and painful operation, and the hemorrhage is most embarrassing. Larghi has removed both bones through the mouth, upon the cadaver, and says it is easier to remove both together than one alone in this way.

In simultaneous excision of both superior maxillæ, the same incisions may be made on both sides, as for the removal of only one, or Dieffenbach's median incision may be made along the ridge of the nose and the middle of the upper lip.

Operation by one of the Median Incisions. (Fig. 89.) —The incision is made in the direction selected, the knife penetrating to the bone throughout except at the lip. The cartilage of the nose is separated from the bone and reflected inward with the small internal flap, the edge of the orbit cleared, and the external flap dissected outward as far as to the malar bone above and the tuberosity of the maxilla below if possible, the infraorbital nerve being divided at its point of emergence from the foramen.

The periosteum of the floor of the orbit is then detached with the handle of the knife, as far as the spheno-maxillary fissure, the malar process or bone cut through with the saw or forceps, and the thin plate of bone forming the floor of the orbit divided with the knife obliquely inward and forward from the anterior end of the spheno-maxillary fissure. The superior maxillary nerve, which can be readily distinguished through the bone, should also be divided as far back as possible. Finally, the nasal process is divided.

FIG. 89.



Excision of superior maxilla. *A.* External incision. *B.* Nélaton's incision. *C.* Boeckel's incision.

The incision is then carried through the lip, and the detachment of the external soft parts completed.

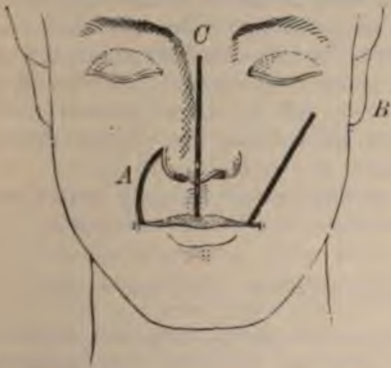
The mucous membrane of the roof of the mouth is divided transversely on a line with the last molar tooth, and longitudinally in the median line. An incisor tooth is then drawn, and the hard palate divided with saw or forceps close to the septum.

If the mucous membrane of the roof of the mouth is not diseased it may be retained. Instead of the incisions through it just mentioned, one is made along the inner border of the alveolar process, its edge raised, and the membrane detached inward and backward to the median line. After the removal of the bone it unites with the cheek, closes in the mouth as before, and may become strengthened by a deposit of bone.

Finally, the bone is grasped with strong forceps, twisted downward to break its posterior connections, and removed, generally bringing with it part of the palate bone, the hamular process of the pterygoid and some attached muscular fibres.

Subperiosteal Excision (Ollier).—This method can be employed with any of the median incisions above mentioned, but Ollier prefers an external one (Fig. 90, *B*).

FIG. 90.



Excision of superior maxilla. *A* Guérin's incision. *B*. Ollier's incision. *C*. Dieffenbach's incision for removal of both bones.

1. *Cutaneous Incision.*—An incision is made from the middle of the malar bone to a point on the upper lip one-third of an inch from the angle of the mouth. If necessary, a second incision must be made at the middle of the lip and carried upward around the nostril.

2. *Incision of Mucous Membrane.*—The incision is begun on the outer surface at the interval between the second incisor and the canine tooth (he does not remove the intermaxillary bone, that which supports the incisor teeth) close to the edge of the gum, carried back around the last molar, then forward on the inside to a point corresponding to that at which it was begun, and thence obliquely backward to the median line. A short incision through the periosteum is next made from the anterior external extremity of the former upward and inward to a point a quarter of an inch external to the anterior nasal spine.

3. *Separation of the Periosteum.*—The periosteum of the anterior surface is then detached with an elevator, care being taken, however, to divide the infraorbital nerve with a knife at its point of emergence, and the denudation is carried along the floor of the orbit. Unless it is necessary to remove the nasal process of the maxilla, the lachrymal sac and duct can be left uninjured and adherent to the periosteum.

The periosteum of the roof of the mouth is then separated from without inward as far as the median line.

4. *Section of the Bone.*—The nasal and malar processes are divided with forceps, chisel, or chain-saw as before described, the canine tooth drawn, the edge of the chisel inserted in the gap left by it, and pressed gently backward and inward to the median line, thence directly backward along the suture.

The bone is then twisted out, the palatal sutured to the external periosteum, and the wound closed.

SIMULTANEOUS EXCISION OF BOTH SUPERIOR MAXILLÆ.

An incision may be made from each angle of the mouth to the malar bone and the broad flap reflected toward the forehead, or Dieffenbach's incision made along the ridge of the nose (Fig. 90, *C*), with or without a transverse one passing across it and below the margin of each orbit.

The bones are removed together, not separately. The malar processes or bones are divided in the usual manner, the nasal processes divided with a chain saw passed from one orbit to the other through the lachrymal bones, and the vomer separated with cutting forceps. The periosteum of the hard palate is separated from the gums by a semicircular incision and dissected back, the posterior connections broken and the bone removed by twisting it downward and forward.

PARTIAL AND TEMPORARY EXCISION OF THE SUPERIOR MAXILLA TO FACILITATE THE REMOVAL OF NASO-PHARYNGEAL POLYPS.

Resection of Posterior Portion of Hard Palate (Nélaton).—The soft palate is first divided from before backward along the median line, and the incision prolonged forward through the periosteum of the hard palate as far as may be judged necessary. A transverse incision is next made on one side from the anterior extremity of the first toward the teeth, and the flap, including half the soft palate, dissected off the bone from the median line outward. The mucous membrane on the floor of the corresponding nostril is then divided close to the septum, the bone perforated at the anterior corners of the denuded surface, and the separation of the quadrilateral piece accomplished with cutting forceps.

After removal of the polyp the soft parts are replaced and stitched together. The bone is sometimes reproduced.

Resection of the Upper Portion, leaving the Hard Palate and Alveolar Process (Von Langenbeck).—The following is somewhat abridged from the description in the *Deutsche Klinik*, 1861, page 283:

An incision convex downward, from the ala of the nose to the malar bone, and along the zygoma backward. A second incision from the nasal process of the frontal along the lower border of the orbit, meeting the first at the middle of the malar bone.

He worked down to the bone through the first incision and separated the attachments of the masseter to the malar bone. As soon as the tense *fascia buccalis* was cut the tumor appeared. Drawing the inferior maxilla away with a speculum, he easily passed his finger between the tumor and the superior maxilla through the pterygo-maxillary fissure into the spheno-maxillary fossa, both of which had been enlarged by pressure, and then through the dilated foramen spheno-palatinum to the cavity of the nose.

A fine elevator and then a fine keyhole saw were passed by the same route, and the superior maxilla sawn through horizontally from behind forward, while the left forefinger, passed through the mouth into the pharynx, covered the point of the saw and kept it from striking against the septum of the nose.

The second incision was then carried down to the bone and into the orbit, and the soft parts divided in the angle between the frontal and zygomatic processes of the malar bone.

The second cut with the saw was then made from below upward through the zygomatic process of the temporal and the frontal process of the malar bone to the spheno-maxillary fissure, and thence across the floor of the orbit to the lachrymal bone.

The resected portion was thus left attached only to the nasal bone and the nasal process of the frontal by its own uninjured nasal process. The hard palate and alveolar process had not been touched.

He then passed an elevator under the malar bone and turned the piece slowly upward upon its connections as upon a hinge until the malar bone had nearly reached the median line of the face, and the spheno-maxillary and nasal fossæ were completely accessible.

The bleeding was severe, but stopped spontaneously, the arteria spheno-palatina alone was tied at its entrance into the foramen spheno-palatinum.

The bone was replaced and nicely adjusted, its tendency to rise being restrained by pressure until the metallic sutures had been set in the skin.

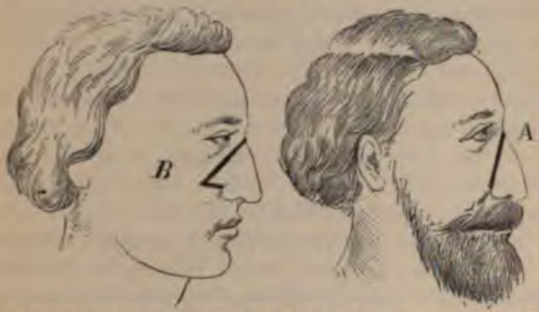
OTHER METHODS OF GAINING ACCESS TO THE PHARYNX THROUGH THE NOSE.

These may here be described, although, properly speaking, they are not resections of the superior maxilla.

Boeckel makes two transverse cuts across the nose, and unites their extremities by a third along its side. The cuts are carried to the bone, and the quadrilateral osteo-cutaneous flap thus formed turned back upon the cheek, the other nasal process which forms its base having first been broken with padded forceps, one blade of which is passed into the nostril.

Ollier turns the whole nose downward. He begins his incision at the edge of the bone close behind the ala of the nose carries it upward along its side to the highest part of the depression between the eyes, then across and down to the corresponding point on the other side (Fig. 91, *A*). The bone is sawn through in the line of the incision, the necessary liberating incisions made in the septum or the sides, and the nose turned down.

FIG. 91.



Ollier's operation for removal of a naso-pharyngeal polyp. *B.* Modification for a very large polyp.

The septum is pressed aside, the polyp extracted, its base of implantation scraped, and the nose replaced.

A modification, which is sometimes desirable on account of the size of the polyp or the distance of its implantation, is indicated in Fig. 91, *B*. The incision runs more obliquely backward, and a transverse one is made from each end to the ala of the nose. The bone is divided in the direction of the cutaneous incisions, in the vertical one as before described, in the horizontal one by passing a fine saw across the nostrils through holes made between the bone and cartilages, and sawing backward. This line of section must be high enough to avoid the roots of the teeth.

In some cases it is sufficient to mobilize the *lower end of the nose* by an incision under the lip in the gingivo-labial fold, and then by carrying it and the lip upward very free access to the nasal fossæ is obtained.

EXCISION OF THE INFERIOR MAXILLA.

This may be total or partial; and partial excision may involve the removal of any part of the body of the bone or of the ascending ramus. Partial excision of the body may sometimes be accomplished through the mouth without the aid of a cutaneous incision, or by an incision along the lower border of the bone with or without another at right angles to it extending toward or even through the lip, or by two vertical incisions downward from the angles of the mouth when only the upper part of the body of the bone is to be removed.

When the ascending ramus also is to be resected the incision should pass along the lower border of the bone to the angle of the jaw, and then upward along the posterior border of the ramus to the level of the lobule of the ear. If the incision is carried higher the facial nerve is necessarily divided with consequent paralysis of the muscles supplied by it, a complication which should be avoided, notwithstanding the assertion of some authors that the paralysis may disappear after a time. The horizontal portion of the incision should be a little below the border of the bone in order that the cicatrix may be less conspicuous. Syme removed the entire ramus with the condyle, without opening into the cavity of the mouth, by an incision slightly convex backward extending from the zygoma to, and a little beyond, the angle of the jaw.

The principal danger is of injury to the internal maxillary artery, which lies almost in contact with the inner side of the neck of the condyle. The lingual nerve also is in close relation with the inner side of the ramus, lying between it and the internal pterygoid muscle. Maisonneuve introduced a modification of the method of operating which has rendered it almost easy and has diminished the above-mentioned danger. It consists in separating the attachments of the condyle by twisting and tearing out the bone after all the connections have been divided. If this modification, which sounds, perhaps, rougher and less surgical than it really is, is not adopted, the joint must be approached from in front so as to avoid the external carotid, which lies close behind the bone in the substance of the parotid. It is sometimes allowable to divide the neck of the condyle, or even the ramus below the sigmoid notch, with cutting pliers, and leave the upper fragment in place.

Another danger is in the division of the attachments of genio-hyo-glossus muscles to the bone. The tongue, deprived of its support, falls back upon and closes the glottis. As a preliminary, therefore, to any operation in which these attachments are divided, a stout ligature should be passed through the tip of the tongue and held by an assistant. After the operation it should be fastened to a harelip pin in the external incision, or to the skin of the face by a strip of adhesive plaster, and retained for a couple of days, at the end of which time the muscles will usually have formed new attachments.

The bone should be sawn through with a chain or common saw, according to circumstances, or merely nicked with the saw, and its division completed with cutting-pliers. The tooth occupying the proposed line of section should first be drawn.

Ligature of one or both carotids has been proposed and performed as a preliminary operation to prevent excessive hemorrhage, but it has proved to be not only unnecessary but ineffectual. In Mott's case the main operation had to be adjourned to allow the patient to recover from the shock of the preliminary one. In another case in which both carotids had been tied, the main operation had to be abandoned on account of hemorrhage.[1] Syme says the preliminary ligation is unnecessary, because the only arteries that need to be divided are the facial and the transverse branches of the temporal, bleeding from which can be easily controlled, and, furthermore, all the advantages offered by ligation of the carotids can be obtained by their temporary compression during the operation.

The attempt should be made, when possible, to get primary union of the intra-buccal wound and to drain through the external one. This makes it easier to keep the wound sweet, diminishes the danger of purulent infection, and avoids the risks incident to the swallowing of the decomposing discharges.

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[1] Mentioned by Syme in *Contributions to the Pathology and Practice of Surgery*, Edinb., 1848, p. 19.

The results of the operation are usually very good, and the deformity less than might be expected. Subperiosteal excision has been followed by reproduction of the entire bone with condyles and diarthrodial cartilages, and even when the periosteum is not preserved the cicatrix becomes very firm and fibrous, and able to support a plate with artificial teeth.

Resection of the Anterior Portion of the Body.—This may be done by means of a vertical incision in the median line, or of a horizontal one below the free border of the bone, or from within the mouth without any cutaneous incision.

If one of the incisions is made, the external and internal surfaces of the bone are cleared through it, a tooth drawn at each of the proposed points of section, and the bone sawn through.

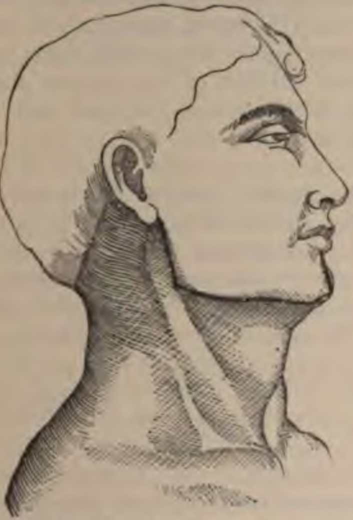
If no external incision is made, the external surface of the bone is cleared, beginning at the edge of the gum or in the gingivo-labial fold, according as the periosteum is or is not to be preserved, and the lip drawn down under the chin so that the bone protrudes through the mouth. It can then be easily sawn through and freed from its attachments on the inner side.

Resection of the Lateral Portion of the Body.—The incision extends along the lower border of the jaw from its angle nearly to the symphysis, and then is carried vertically upward to the base of, but not through, the lip. The flap is dissected up, the elevator being used, of course, if the periosteum is to be preserved, the inner surface of the bone cleared near the symphysis for the passage of a chain-saw, and the section made if possible at a short distance from the median line, so as not to disturb the insertion of the genio-hyo-glossus. This section may be made with a narrow saw from before backward if preferred.

The bone is then drawn downward and outward, its inner surface cleared, and the saw applied behind the last molar tooth or at any suitable point.

Resection of the Ramus and Half of the Body. (Fig. 92.)—An incision is begun close to the posterior border of the ramus on a level with the lobule of the ear, carried down to the angle of the jaw, and thence along its lower border to the symphysis, where it is met, if necessary, by a vertical one, beginning below the free border of the lip a little to that side of the median line on which the bone is to be removed. The flap thus marked out is dissected up from the bone as far as can be done without opening into the buccal cavity, and the divided facial artery tied. The inner surface of the bone is then cleared in the same manner, an incisor tooth drawn, and the bone sawn through.

Fig. 92.



Excision of inferior maxilla.

The jaw is then drawn downward and forward, the denudation of its inner surface completed by dividing the attachment of the mucous membrane and of the internal pterygoid, and the inferior dental nerve cut squarely across at the point where it enters the bone.

The insertion of the temporal muscle upon the coronoid process is divided with curved scissors while the jaw is forcibly depressed, or the process itself is cut through if it is so long that its extremity cannot be reached.

The remaining soft parts are carefully detached upward toward the condyle, the knife, or, better, the elevator or the handle of the scalpel, being kept close to the bone, and the separation completed by twisting the jaw out.

Excision of the whole of the Inferior Maxilla.—The incision is made from the lobule of one ear down to the angle of the jaw, along the lower border of the bone to the other angle, and then up to the lobule of the other ear. The outer and inner surfaces of the jaw are denuded, the bone sawn through in the median line, and each half removed as before described.

In the *subperiosteal method* the incisions are the same, except that the vertical incision may be in the median line, since the genio-hyo-glossus and genio-hyoid muscles remain attached to the periosteum. The attachment of the temporal muscle is not cut but is freed with the elevator, as is also that of the external pterygoid to the condyle.

ANCHYLOSIS OF THE JAW.

The most common cause of anchylosis of the jaw is found in cicatricial retraction or adhesions left behind by intra-buccal ulceration. Rizzoli (1858) was the first to point out that the proper aim of an operation intended to relieve this infirmity should be the establishment of a pseudarthrosis in front of the adhesions or cicatricial bands when the cause itself could not be removed. His operation consisted in the division of the inferior maxilla behind the last molar tooth by means of a specially constructed osteotome introduced through the mouth. Bony union of the fracture was then to be prevented by motion. Esmarch (1859) proposed the removal of a wedge-shaped piece of the bone.

By some surgeons the base of the wedge is taken from the alveolar process, by others from the lower border of the jaw. Dieffenbach proposed to divide the ascending ramus horizontally from before backward by means of a chisel passed through the mouth to the anterior border of the ramus.

Operation (removal of wedge-shaped piece).—An incision is begun at the angle of the jaw and carried two inches forward along the lower border. A narrow strip of bone is then cleared on both sides up to the edge of the gum, a tooth drawn if necessary, the chain-saw passed around the bone through the incision, and the section made. The anterior fragment is then depressed and protruded through the wound, and a wedge-shaped piece from one-third to one-half of an inch in width at its widest part cut off with cutting forceps.

Excision of the Condyle.—This may be required for the relief of anchylosis due to bony or fibrous union between the condyle and the temporal bone. The incision is begun at the lower margin of the zygoma close in front of the temporal artery where it adjoins the ear, and carried forward along the zygoma about one and a quarter inches, the tissues being divided layer by layer until the bone is reached. A second incision, involving only the skin, is then carried from the centre of the first directly downward for about an inch. The soft parts are next carefully separated with knife and elevator from the margin of the zygoma and the outer surface of the joint and drawn downward with a hook, thus preserving the parotid, nerves, and vessels from injury. The neck of the condyle is then freed by working around in front and behind with a small elevator, keeping close to the bone so as to avoid injury to the internal maxillary artery, and finally divided with the chisel. If there is bony union between the condyle and temporal bone the chisel must be again used to separate them, its edge being kept directed somewhat downward so as not to break through into the cavity of the cranium.

RESECTION OF THE STERNUM.

Ollier[1] reports the following case: Vertical incision four inches long; detachment of periosteum, and removal of a "red vascular sequestrum one and one-quarter inches square, adherent to the rest of the bone only by medullary granulations." The adjoining rarefied bone was gouged away, portions of the internal plate being left at a few points. The projecting and denuded ends of two costal cartilages, the fourth and fifth, were cut off.

Three years afterward the patient died of phthisis, and the autopsy showed reproduction of all the parts removed.

RESECTION OF THE RIBS.

This is best performed in those regions where the bone is covered by a thin muscular layer. In the middle third of the rib the intercostal artery lies in a groove on the inner side of the lower border.

The incision should correspond in length and direction with the portion of bone to be removed, and should be crossed at each end by a short transverse one. The flaps are then dissected up, the periosteum separated as far as possible, a chain-saw passed at the limits of the diseased portion, and the piece removed. Instead of the saw, cutting-pliers may be used.

In *Estlander's operation for empyema* (thoraco-plastik), in which portions of several adjoining ribs are resected to allow the chest wall to sink inward and unite with the visceral pleura, the position of the incision is usually determined by that of the fistula. The incision is made along the intercostal space occupied by the fistula, and the adjoining ribs resected as above described. The limits of the cavity are then determined, and other ribs resected, if necessary, through a vertical incision made from the centre of the first. If the costal pleura is so thick as to prevent the attainment of the desired object, it must be cut away from a sufficient part of the area of resection. From three to six ribs have been thus resected, in lengths varying from one to three inches. The operation has been restricted to the ribs between the third and eighth, but in one case a small portion of the clavicle also was removed. Sometimes the thickened visceral pleura has also been dissected off.

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[1] Traité de la Régénération des Os, vol. ii. p. 53.

EXCISION OF THE CLAVICLE.

On account of the proximity of the large vessels of the neck this has been considered the most dangerous of all the excisions. The danger, however, varies greatly with the nature and extent of the disease which renders the operation necessary. Thus, when there is osteitis with thickening and loosening of the periosteum, the operator can easily keep close to the bone, and the danger of injury to the vessels, as well as of exciting diffuse inflammation below the deep fascia, is reduced to the minimum. On the other hand, when caries has existed for a long time, the soft parts have become infiltrated and bound down, and the bone thickened and roughened, the difficulties are immensely increased; and when the bone is the seat of a malignant tumor, extending in all directions, its removal may tax the powers of the most skilful. Valentine Mott spoke of his case as the most difficult and tedious operation he had ever witnessed or performed; it lasted four hours, and more than forty ligatures were applied, including two upon the internal jugular vein.

As only the inner half of the bone is in close relation with the vessels, and the danger is especially great at the sterno-clavicular joint, it is advisable first to raise the outer end of the bone from its place by opening its articulation with the acromion or by dividing it a little to the inner side of that joint, and then, after clearing the posterior surface from without inward, to divide the attachments of the inner end while twisting the bone upward about its long axis, and keeping the edge of the knife against it. When this is impracticable the periosteum must be carefully separated near the middle, and the bone sawn through with the usual precautions against injury to the underlying parts. Each half is then raised in turn and dissected out.

For the removal of a tumor no fixed rules can be given. In other cases the directions are as follows:

Operation.—The subperiosteal method must be employed throughout. The incision is made along the anterior surface of the bone, and corresponds in length with the portion to be removed. A short transverse incision is then made at each end of the first, the flaps dissected up, and the denudation carried as far as possible around the bone above and below.

The bone is then freed at its acromial end, or divided in the middle, and the separation completed as above described.

EXCISION OF THE SCAPULA.

It is impossible to lay down fixed rules for making the incisions when the operation is rendered necessary by a tumor of the bone. They will be determined by the circumstances of the case and especially by the extent of the disease, for while in some cases the acromial end of the clavicle must also be removed, in others the acromion and neck of the scapula may be left behind.

Mr. Holmes[1] says: "The surgeon turns down appropriate skin-flaps. . . . When the whole tumor is thus exposed, the muscles inserted into the vertebral border of the bone should be rapidly divided, as also those which are attached to the spine of the scapula. The tumor should be lifted well up and freed from its other attachments, commencing from its lower angle. The subscapular artery is divided near the end of the operation, and can be held till the tumor is removed, or can be at once tied. The ligaments of the shoulder are then easily divided and the mass removed."

Gross[2] made a vertical incision sixteen inches long downward from the superior angle of the scapula, and circumscribed an oval portion by a second curved incision, beginning five inches below the upper end of the first and ending about the same distance above its lower end, and removed the bone after sawing through the acromion and neck of the scapula.

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[1] A Syst. of Surgery, vol. v. p. 669.

[2] Gross's Syst. of Surgery, vol. ii. p. 1078.

Velpeau[1] recommends three incisions: one along the spine of the scapula, the others starting from the anterior extremity of the first and running, one toward the root of the neck, the other toward the axilla behind.

Syme made two incisions crossing each other near the centre of the tumor. Other surgeons have made triangular or semilunar flaps.

In January, 1878, Dr. George A. Peters removed, at the New York Hospital, the entire scapula for malignant disease, leaving the arm. He made an incision along the spine of the scapula, divided the fibres of the deltoid and trapezius, and exposed the tumor, which involved only the acromion and adjoining portion of the spine. He then made a vertical incision across the centre of the first, beginning two inches above it and extending to the inferior angle of the scapula, reflected the flaps, dissected out the under surface of the bone from behind forward, separated the acromion from the clavicle and humerus, and then, raising the lower angle of the scapula toward the head, approached the coracoid process from below, and found no difficulty in separating it from its attachments. Only two vessels required ligation, the supra-scapular and a large branch of the subscapular. The operation was performed under the spray, and the wound treated antiseptically. The result was very good; six weeks afterward the wound had closed, and the patient possessed a certain degree of control over the humerus.

Subperiosteal Excision of the Scapula (Ollier). Fig. 93. 1. *Incision of the Skin and Muscular Interstices.*—An incision is made along the whole length of the spine of the scapula, and from its posterior extremity two others are made, one following the posterior border down to the inferior angle, the other running obliquely forward and upward for about an inch. A short transverse incision may al needed at the anterior end of the first.

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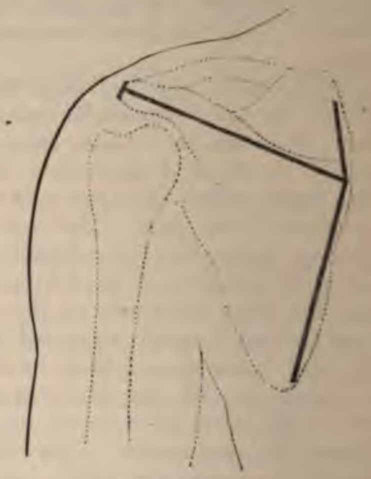
[1] Médecine Opératoire, vol. ii. p. 659.

2. *Denudation of the Bone.*—The attachments o deltoid and trapezius to the acromion and spine are rated, the periosteum of the posterior border of the sc divided in the interstice between the rhomboideus and i spinatus, and the infra-spinous fossa carefully denuded.

FIG. 93.



Excision of the scapula.

periosteum is very thin in its lower third. The lower is freed by detaching the teres major and serratus ma the bone raised, and the subscapularis detached from b upward. If the marginal cartilage is not completely os and united with the bone, it should be separated and adherent to the periosteum.

The supra-spinous fossa is then cleared, care being t not to injure the supra-scapular nerve in the supra-sca notch, but to raise it up with the periosteum and its fi sheath. The posterior part of the bone is then carried ward and forward, and the denudation of its under su and anterior border completed.

If the extent of the disease permits, the denudation sh stop at the neck of the scapula, which is then divided with a chain-saw or cutting forceps.

3. *Opening of the Scapulo-humeral Joint. Detachment of the Articular Capsule and Denudation of the Coracoid Process.*—The acromion is next separated from the clavicle, the scapula turned upward, the joint opened from below, and as the bone is pressed steadily upward everything that holds is detached with an elevator. After the coracoid process has been thus separated from most of its muscular and ligamentary attachments, the few that remain can be broken by twisting the bone away. In suitable cases the coracoid process may be divided at its base and left in place, and thus the most difficult and laborious part of the operation done away with.

The partial excisions of the scapula do not require detailed description. The acromion, spine, and posterior border are reached by straight or slightly curved incisions along the portion to be removed. A crucial or H incision is required at the angles.

RESECTION OF THE HUMERUS.

The position of the musculo-spiral nerve is the most important element in this operation. In its passage around the posterior aspect of the humerus the nerve lies close to the bone within the sheath of the triceps muscle, and leaves the latter on the outer side of the arm to enter that of the supinator longus at its origin. In approaching the bone, therefore, on the outer side near the junction of the middle and lower thirds, the operator should lay bare the outer border of the brachialis anticus and follow down within its sheath to the bone.

Upper Portion.—Same incision as in Ollier's method of excision of the shoulder carried further down along the outer edge of the biceps. The cephalic vein must be sought for and drawn aside. Periosteum and capsule divided, bone denuded and removed as in excision of the shoulder-joint (*q. v.*).

Middle Portion.—Incision along the posterior border of the deltoid and outer edge of the biceps. Outer border of the brachialis anticus laid bare and followed down to the bone. Division of the periosteum and denudation of the bone with especial care for the safety of the musculo-spiral nerve.

Ollier prefers to seek the nerve and draw it aside. He also recommends that whenever it is possible to leave a portion of the shaft connecting the extremities it should be done, as a precaution against shortening and the formation of a pseudarthrosis. If this is not possible the chain-saw is passed at two points, and the intermediate piece removed.

Lower Portion.—Incision on outer side of the posterior aspect of the arm, between the triceps and supinator longus, as in Ollier's excision of the elbow (*q. v.*).

Total Excision.—Combination of incisions for upper and lower portions. After the ends have been denuded of periosteum the middle portion can be cleared by pushing one end out through its incision and peeling the periosteum back like the finger of a glove until the middle is reached. The bone is then sawn off, and the other half removed in a similar manner through the other incision.

EXCISION OF THE ULNA.

Longitudinal incision along the posterior aspect of the bone, joined at its upper end by a short one running obliquely upward and outward between the triceps and anconæus. The triceps is drawn to the inner side, and the olecranon freed. After separation of the periosteum the bone is sawn through in the middle, and each piece is dissected out in turn.

EXCISION OF THE RADIUS (OLLIER).

An incision involving the skin only is made from the styloid process of the radius along the outer border of the forearm to the radio-humeral articulation. The fascia is divided and the posterior border of the supinator longus found. By following it toward the wrist the knife can be kept between it and the extensor tendons of the thumb, which can then be drawn backward and saved from injury. By following it upward the interstice between it and the extensores carpi radiales is found, through which the operator penetrates to the radius now covered only by the supinator brevis. The latter muscle is then divided longitudinally and the periosteal sheath opened.

The periosteum is detached laterally, the bone sawn through at its middle, and each fragment removed separately.

Partial Excisions of the Ulna and Radius.—The incisions and methods are the same as those above described.

EXCISION OF THE METACARPAL BONES AND PHALANGES.

The metacarpal bones should be exposed by a longitudinal incision along the dorsum. As the extensor tendons cross the bones obliquely this incision should involve only the skin at first, the tendon is then drawn aside, and the incision carried down to and through the periosteum, which must be retained when possible. It is advisable that the joints, especially the metacarpo-phalangeal, should not be opened.

The bone is then divided in the middle with cutting forceps and each end dissected out, or the gouge alone may be used.

The after-treatment is important. Extension must be made upon the corresponding finger for a long time to keep it from being drawn up into the hand. In the case of the metacarpal bone of the thumb lateral pressure must also be made.

For *resection of a phalanx* the incision should be made on the side of the finger near the dorsum. For the terminal phalanx the incision should be **U**-shaped, the arms passing along the sides of the phalanx, the curve around its end.

Resection of the different portions of the thumb, even if not subperiosteal, is to be preferred to amputation, but the contrary is true of the phalanges of the other fingers.

Lateral pressure, by means of splints or an India-rubber glovefinger, and extension by weight must be made to insure the necessary length and proper shape of the member.

RESECTION OF THE BONES OF THE PELVIS.

Ollier[1] reports a case in which he removed the ascending ramus of the ischium and most of the pubis for suppurative osteo-arthritis of these bones and the pubic synchondrosis. The incision was about four inches long and extended from a fistula in the genito-crural fold up toward the pubis. The periosteum was detached, the ascending ramus of the ischium removed, and then the ascending ramus, body, and part of the horizontal ramus of the pubis. The bone that was removed was eroded and rarefied, but not necrotic.

EXCISION OF THE COCCYX (OLLIER).

This may be required on account of disease of the coccyx, or as a preliminary to operations upon the rectum. Ollier has removed it for osteitis, Simpson and Nott for the relief of coccygodynia, and Verneuil in cases of imperforate anus, and to facilitate the removal of cancers of the rectum.

The limits of the bone are determined by the finger in the rectum, and a longitudinal incision made through the skin and fibrous covering of the bone, from a quarter of an inch above its upper to the same distance below its lower end, and a transverse incision made at the upper end of the first. The posterior surface of the bone is then denuded.

The sacro-coccygeal articulation having been opened by this denudation, its fibro-cartilage is divided, and the cornua cleared on both sides. An elevator is then passed through the joint and used as a lever to force out the coccyx, peeling off at the same time the fibrous covering of its anterior surface.

If the sacrum is also diseased, and the gouge is used upon it, it must be remembered that the sacral canal extends to its very end, and is there formed posteriorly not of bone, but of fibrous tissue.

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[1] De la Régénération des Os, vol. ii. p. 180.

RESECTION OF THE SHAFT OF THE FEMUR.

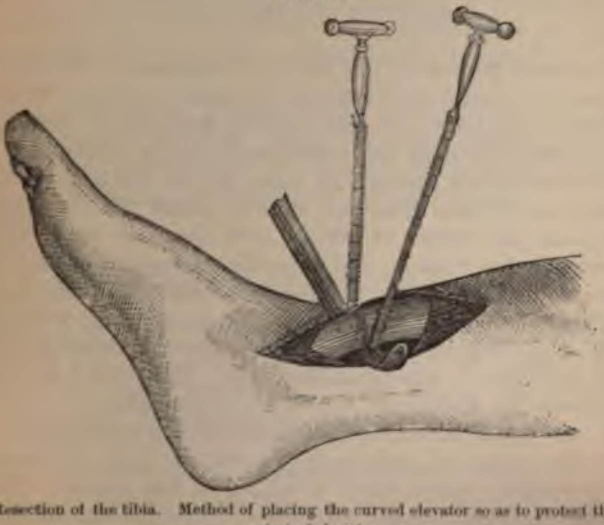
A longitudinal incision is made on the outer side in the groove between the vastus externus and biceps, with a transverse liberating incision at each end. Denudation is carried as far around as possible, the chain-saw passed at each end of the diseased portion, and the denudation completed as the piece is raised from its bed.

In the case of a child extension should be made, and the limb kept of the same length as the other; in the case of an adult the fragments should be brought nearer together as the patient is older, and his power of regeneration less; and, in many cases, it is better to bring the fragments into contact. Shortening is less of an infirmity than pseudarthrosis.

RESECTION OF THE SHAFT OF THE TIBIA (OLLIER).

(Fig. 94.) A longitudinal incision is made along the inner surface of the tibia near its posterior border. The perios-

FIG. 94.



Resection of the tibia. Method of placing the curved elevator so as to protect the periosteal sheath.

teum is incised, and the bone denuded. For the latter purpose it is necessary to use a well-curved elevator, because the sharpness of the angles of the bones makes it very difficult to get around them without perforating the periosteal sheath. After the denudation is completed at one point, the curved elevator is passed behind the bone, and then the chain-saw along its groove. The bone is divided, the elevator withdrawn, and each fragment raised in turn and cleared along its posterior surface and borders. If the periosteum is loosely adherent, it may be stripped off by passing the elevator up and down in the sheath behind the bone.

In resection of only a portion of the diaphysis it is better to saw through the bone at each end of the portion that is to be removed.

The bone is necessarily denuded for some distance beyond the proposed line of section, but this distance may be diminished by a transverse incision through the periosteum at that point. Moreover, necrosis of the denuded part rarely follows.

RESECTION OF THE FIBULA.

The lower portion of the fibula is subcutaneous, its upper portion is covered by the peroneal muscles. The biceps is attached to its head, and the external popliteal or peroneal nerve after following the posterior border of the tendon of that muscle winds around the outer side of the neck of the fibula, and divides into the anterior tibial and musculocutaneous, the latter of which soon becomes superficial. Sometimes this division, and even the subsequent ones, take place as high up as the head of the fibula, and then there is danger of dividing some of the branches during resection of the upper extremity of the bone, unless the method indicated by Ollier is strictly carried out. The earlier authors considered the division of this nerve unavoidable.

As the upper tibio-fibular articulation communicates in a large proportion of cases with that of the knee, it should not be opened, except when it shares in the disease. The head of the fibula should be divided or gouged out in such a way as to leave this articulation covered by a thin but complete plate of bone.

Resection of the Upper Extremity of the Fibula (Ollier).[1] —A longitudinal incision is begun an inch above the head of the fibula at the posterior border of the tendon of the biceps, and carried down a little behind the bone along the interstice between the soleus and the peroneal muscles. The incision should involve only the skin and fascia.

The nerve is then sought for where it passes around the neck of the fibula, and protected by two blunt hooks placed about an inch apart. While thus protected, it is freed from the cellular tissue, which binds it to the bone, and then drawn forward so as to permit the division of the periosteum. This division is made on the posterior border of the bone, and carried downward as far as is necessary in the interstice between the soleus and peroneal muscles.

The periosteum is then detached and the bone removed, either by dividing it at two points with a chain-saw and removing the intermediate portion, or by dividing it at the lower limit of the disease, and twisting out the upper fragment, or by modifying the latter method to the extent of dividing the head of the bone with a sharp chisel in such a manner as to leave the tibio-fibular joint unopened.

Resection of the Lower Portion of the Fibula.—Longitudinal incision along the antero-external aspect of the bone. Denudation and removal of the bone in the usual manner. For other details, see excision of the ankle-joint.

EXCISION OF THE WHOLE FIBULA.

As the incisions for the resection of the upper and lower portions lie on opposite sides of the peroneal muscles, they cannot be made continuous with each other. Each half of the bone must be removed separately.

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[1] Traité de la Régénération des Os, p. 267.

EXCISION OF THE BONES OF THE FOOT.

Calcaneum.—Disease of the tarsal bones is apt to originate in the calcaneo-astragaloid articulation and then involve the calcaneum mainly, the astragalus being only superficially affected. The disease in the former is usually central, leaving a sequestrum inclosed in a shell of rarefied vascular bone, or a cavity is formed within a similar shell by ulceration and discharge through one or more fistulæ. The removal of the entire thickness of the bone gives better results than simple gouging out of the diseased portions, *évidement de l'os*, but the anterior portion should if possible be left, as it favors reproduction of the bone.

The English surgeons do not usually employ the subperiosteal method, claiming[1] that the results obtained by the ordinary method are so good that they are disinclined to make any change. So far as can be judged from the published descriptions, these results, although satisfactory so far as the restoration of function is concerned, are inferior to those obtained by the subperiosteal method. The absence of the calcaneum destroys the plantar arch and the sightliness if not the usefulness of the foot, whereas in some of Ollier's subperiosteal cases the new heel was as prominent and firm as that of the other foot.

A. *Holmes's Method.*—An incision is commenced at the *inner* edge of the tendo Achillis, and drawn horizontally forward along the outer side of the foot to a point somewhat in front of the calcaneo-cuboid articulation. This incision should go down at once upon the bone, so that the tendon should be felt to snap as the incision is commenced. It should be on a level with the upper border of the os calcis. Another incision is then made vertically across the sole, commencing near the anterior end of the former incision and ending at the outer border of the internal surface of the os calcis. The bone being now denuded by throwing back the flaps, the calcaneo-cuboid and calcaneo-astragaloid joints are sought for and laid open. The calcaneum having been thus separated from its bony connections by the free use of the knife, aided, if necessary, by the lever, lion-forceps, etc., the soft parts are next to be cleaned off its inner side with care, in order to avoid the vessels, and the bone will then come away.

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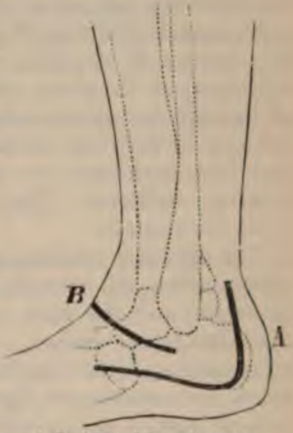
[1] Holmes, System of Surgery, vol. v. p. 720.

B. *Subperiosteal Method* (Ollier). Fig. 95, *A*.—An incision involving only the skin is begun at the outer border of the tendo Achillis about an inch higher than the tip of the external malleolus, carried down below the outer tuberosity of the calcaneum and then forward and slightly upward to the upper part of the base of the fifth metatarsal. The edge of the tendo Achillis and the upper border of the plantar muscles being recognized, the incision is carried down to the bone, care being taken not to cut the peroneal tendons.

The posterior half of the bone is then denuded with an elevator, and the tendo Achillis detached and pressed to the inner side. The under surface and posterior third of the inner surface are next cleared, the peroneal tendons drawn aside with blunt hooks, the external lateral ligament detached, the anterior portion of the outer surface denuded, and the calcaneo-cuboid joint opened.

FIG. 95



A. Excision of the calcaneum.
B Excision of the astragalus.

The interosseous ligament is divided with a narrow bistoury, the bone grasped with lion-forceps and turned downward so as to open the calcaneo-astragaloid joints and give access to the calcaneo-scaphoid and internal lateral ligaments and to the inner surface of the bone.

It is difficult, if not impossible, to avoid opening some of the tendinous sheaths during the operation, but the damage is very much less than that inflicted by the former method.

Resection of the posterior portion alone can be accomplished much more expeditiously. The portion to be removed is denuded and then sawn off, either directly or by perforating the bone and sawing it from above downward with a chain-saw.

Astragalus.—Excision of the astragalus may be rendered necessary by dislocation, comminuted fracture, or caries, or it may be made as a preliminary step in excision of the ankle. Ollier considers this operation, under normal circumstances, the most difficult of all excisions. He employs the following method on the cadaver.

Operation (Ollier). Fig. 95, *B.*—Curved incision across the dorsum of the foot, with convexity directed forward, beginning on the inner side at the point where the tendon of the tibialis anticus crosses the tibio-tarsal articulation, running forward and outward to the middle of the scaphoid, and then backward to a point a little below the tip of the external malleolus. This incision must expose but not involve the tendons.

The extensor tendons are lifted out of their sheaths and drawn aside, the extensor brevis cut across or detached at its origin, and the neck and outer non-articular surface of the astragalus cleared. The capsular and ligamentary attachments of the bone to the scaphoid and tibia are separated, the interosseous ligament divided, and the foot being turned inward the insertion of the strong internal tibio-astragaloid ligament is detached. The remaining connections are then ruptured by grasping the bone with strong forceps and twisting it out.

Verneuil thinks the operation is made easier by sawing through the neck of the bone and first removing the head.

See also Vogt's excision of the ankle, p. 175.

When *dislocated* the astragalus may be easily removed by a straight, curved, or crucial incision made over the most prominent part, and avoiding vessels, nerves, and tendons.

When *badly shattered*, as in gunshot injury, the fragments may be removed through a longitudinal incision between the extensor tendons of the first and second toes.

For simultaneous removal of the calcaneum and astragalus see *Osteoplastic excision of the foot*, p. 176.

Metatarsal Bones and Phalanges.—A metatarsal bone should be exposed by an incision along the dorsum involving only the skin; the tendon is then drawn aside, the periosteum divided, the bone denuded, sawn through, and removed. Whenever possible, the upper extremity of the bone should be left.

For the first and fifth metatarsals it is better to make the incision more upon the side than upon the dorsum.

If the corresponding toe is to be preserved, extension must be made upon it for a long time, in the manner and for the reasons mentioned under excision of the metacarpal bones.

The phalanges and their articulations are best excised by lateral incisions.

TREPHINING.

Trephining of the Cranium may be undertaken for the evacuation of an intra-cranial abscess or hemorrhagic effusion, or for the removal of a suspected tumor of the bone or meninges, or for the cure of epilepsy, or after fracture to raise depressed portions of the bone. In all except the latter case the advisability of the operation is greatly diminished by the difficulty of determining the point at which the trephine should be applied. Among the more or less trustworthy indications, according to which the surgeon must make his selections of this point, may be mentioned: the history of an injury more or less recent,[1] with or without pain and inflammation of the soft parts (Pott's puffy tumor) at the point where the injury was received, or at one diametrically opposite; constant, well-localized pain at any one point; injury over the course of one of the larger arteries with rapidly supervening symptoms of compression, functional disturbance of certain groups of motor nerves.

The results obtained by certain physiologists in their efforts to determine the location of motor centres in the cortex of the brain have inspired the hope that the injured or compressed portion of the brain might be localized exactly in any given case by consideration of the muscles or groups of muscles paralyzed. This hope has been in part realized and surgical interference has been successfully based upon paralytic symptoms in fracture of the cranium,[1] abscess of the brain,[2] and tumor of the brain.[3]

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[1] In Dupuytren's case there was no sign of the abscess until ten years after the receipt of the injury.

As the motor centres which Broca, Ferrier, Hitzig, and other physiologists claim to have localized lie under the anterior half of the parietal bone and along or near the fissure of Rolando, and as these are the only ones which it has been proposed to seek, it is perhaps desirable that directions should be given for finding this fissure.

According to Lucas-Championnière[4] the fissure of Rolando corresponds to a line drawn from a point on the sagittal suture five and a half centimetres posterior to the bregma (junction of the sagittal and coronal sutures), forward and outward to a point seven centimetres behind and three centimetres above the external angular process of the frontal bone. According to Pozzi[5] the starting-point of this line should be only four and three-quarters centimetres behind the bregma.

The line may be more simply described as the hypothenuse of a right-angled triangle whose base is the upper half of a line drawn from the bregma to the meatus auditorius externus, and whose perpendicular extends two inches backward from the bregma along the median line.

The bregma is situated at the point where a vertical plane passing through both external auditory canals intersects the sagittal suture when the head is held exactly upright.

Whenever it can be avoided, the trephine should not be applied over a sinus or the middle meningeal artery near the anterior inferior angle of the parietal bone. Bleeding from a sinus may be arrested by plugging it with antiseptic gauze, but a fatal result is likely to follow. The middle meningeal artery lies enveloped in the thickness of the dura mater, adhering to it so closely that, when cut, its walls cannot retract sufficiently to arrest hemorrhage. For the same reason it is very difficult to apply a ligature to this vessel, and, as the actual cautery cannot be safely used, the best means of stopping the flow of blood is that proposed by Tillaux, of seizing the vessel and dura mater with spring forceps, and keeping it thus compressed for twenty-four or forty-eight hours.

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[1] Lucas-Championnière, La trépanation guidée par les localisations cérébrales, 1878.

[2] Stimson, Archives of Medicine, April, 1881.

[3] Bennett and Godlee, Lancet, 1885, i. p. 23.

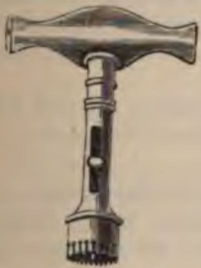
[4] Bulletin de la Société de Chirurgie, 1877, p 121.

[5] Archives Gén. de Méd., Avril, 1877, p. 460.

The *instruments* used in trephining are a stout knife, periosteum elevator, trephine, and a screw-pointed elevator which is intended to be screwed into the hole made by the centre-pin of the trephine, and used to lift out the circular piece of bone after it has been sawn through.

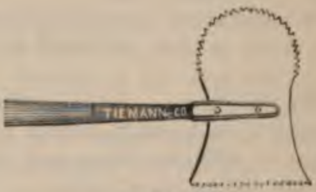
Operation.—A crucial, **V** or **T**-shaped incision, one and a half to two inches long, is made through the soft parts down to the bone, and the flaps, including the pericranium, raised by means of the periosteum elevator. The probability of a reproduction of the bone is increased by preserving the connection of the pericranium with the soft parts.

FIG. 96.



Trephine.

FIG. 97.



Hey's saw.

The centre-pin of the trephine having been protruded one-sixteenth of an inch, and fastened in its place by the binding screw on the side, it is forced by to-and-fro rotary movements upon its point into the bone at the place selected, and these movements continued until the circular edge of the trephine has cut a groove sufficiently deep to insure its steadiness without the aid of the pin, which must then be withdrawn so as to avoid injury by it to the dura mater. The hole made by the pin is then enlarged, and made to fit the point of the screw-pointed elevator so that this instrument can be applied afterward without making too much pressure upon the loose disk of bone.

The rotary movements are repeated very cautiously, and all parts of the groove frequently examined, as its depth increases, with a probe, pen, or quill toothpick, so as to have timely notice of complete perforation. The teeth of the trephine must be freed from the bone dust from time to time by means of a brush or by dipping the instrument into water. If, as is usually the case, perforation takes place upon one side of the groove before it does upon the other, the trephine must be slightly inclined so as to act only upon the unsawn portion, or the elevator may be used to lift out the disk, breaking the thin shell which remains.

If the removal of a much *larger piece of bone* is desired the trephine should be applied successively at two, three, or more points, and the intervening portions sawn through with a Hey's saw (Fig. 97).

In a case of *depressed fracture* the trephine must be applied to the sound bone in such a manner as to overlap the edge of the fracture. The depressed portion is afterward raised by means of an elevator passed through the opening left at the edge of the sound bone by the removal of the incomplete disk.

In *puncturing for a deep-seated abscess* a grooved knife or a trocar is to be preferred to the ordinary flat blade.

Frontal Sinus.—As the walls of the frontal sinus are not parallel to each other, Larrey has proposed to use two trephines of different diameters, the larger for the outer, the smaller for the inner table.

Antrum.—A very small trephine should be used, and, in order to avoid a scar, it should be applied through the mouth after dividing the gingivo-labial fold, and dissecting up the soft parts as far as to the infra-orbital foramen, just below and to the outer side of which the opening into the antrum should be made.

The antrum may also be opened by drawing the first or second molar tooth, and enlarging its socket with a drill.

No additional directions are needed for trephining the *flat bones* or the *epiphyses of the long ones.*

PART V.

NEUROTOMY AND TENOTOMY.

DIVISION AND RESECTION OF NERVES.

Division of a nerve of sensation, or even of a mixed nerve in extreme cases, may be required for the relief of neuralgic pain. It is seldom that simple division is more than temporarily sufficient. At least half an inch of the trunk of the nerve should be excised, and, as additional security against reunion, the end of the distal segment may be bent back upon itself. Prof. Weir Mitchell[1] has seen severe constant pain follow the bending back of the end of the proximal segment.

SUPRA-ORBITAL NERVE.

The *frontal* nerve, main branch of the first division of the trigeminus, divides just behind the upper margin of the orbit into the *supra-orbital* and *supra-trochlear* nerves; both branches are distributed to the forehead, the former emerging from the orbit through the supra-orbital notch or foramen, the latter a little nearer the nose. The former is much the larger and more important of the two, the latter supplying only a narrow strip of integument near the median line. The supra-orbital notch or foramen is found at the junction of the inner and middle thirds of the supra-orbital arch, or a little to the inner side of the junction. When it is a notch it can be readily felt through the skin, and is then an important guide in the operation.

The nerve may be divided subcutaneously after its emergence from the notch, or it may be exposed by a transverse incision above or below the eyebrow.

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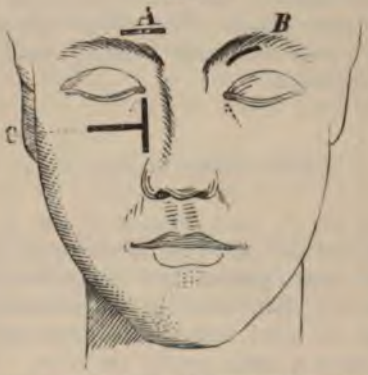
[1] Oral communication.

Subcutaneous Division.—A tenotomy knife is entered between the eyebrows midway between the nerve and the median line, and passed horizontally beneath the skin until its point has passed beyond the nerve. Its edge is then turned backward and pressed against the bone, and the nerve, lying between it and the bone, divided by withdrawing the knife. Or the knife may be entered at the same point, but passed close to the bone instead of just under the skin, its edge turned downward toward the margin of the orbit, and the nerve divided by sweeping the knife downward across the mouth of the supra-orbital foramen.

Excision of a Portion of the Nerve.—A. *Above the Eyebrow.* (Fig. 98, *A.*)—An incision one to one and a half inches long is made just above and parallel to the eyebrow, its centre corresponding to the position of the nerve. This incision is carried down to the bone, the distal end of the nerve recognized, seized with forceps, dissected out, and cut off.

FIG 98



A, B. Resection of supra-orbital nerve. *C* Resection of superior maxillary nerve.

B. *Below the Eyebrow.* (Fig. 98, *B.*)—The eyebrow being drawn up and the eyelid down, the surgeon makes an incision one to one and a half inches in length along the edge of the supra-orbital arch, dividing successively the skin, orbicular muscle, and tarsal ligament. He then seeks the nerve in the notch, traces it back as far as necessary, while depressing the eye and levator palpebræ with a retractor, and cuts out a portion with curved scissors.

Supra-trochlear Nerve.—König resected this nerve by making a curved incision under the eyebrow at the upper inner edge of the orbit, and seeking the trochlea and the superior oblique muscle. On making the latter tense with a hook the two fine nerves became visible, were seized with forceps, and resected.

SUPERIOR MAXILLARY NERVE.

After leaving the cavity of the cranium by the foramen rotundum, the superior maxillary nerve crosses the spheno-maxillary fossa, traverses the infra-orbital canal, and appears upon the face at the infra-orbital foramen, where it at once divides up into numerous branches distributed over the cheek, nose, lip, and lower eyelid. Within the infra-orbital canal it gives off the anterior dental branch, and posterior to this canal it gives off the posterior dental, and through branches to the spheno-palatine ganglion, the palatine nerves distributed to the palate and nasal fossa. The point at which the nerve should be divided will vary according to the region affected, but in this, as in other cases, simple division has usually proved insufficient, and it has been found necessary to excise all that portion of the trunk which lies in the canal. Sometimes the nerve has been cut above the branches going to the ganglion, and the latter torn out forcibly.

The roof of the infra-orbital canal is composed in its posterior half of fibrous tissue, in its anterior half of thin bone which becomes thicker as it approaches the margin of the orbit. The infra-orbital foramen lies directly above the second bicuspid tooth and from one-quarter to one-half an inch below the margin of the orbit. The nerve is accompanied on its passage through the canal by the infra-orbital artery.

A. *Division of the Nerve on the Face.*—This may be done: (1) *subcutaneously;* (2) *through the mouth;* (3) *by an external incision.*

1. *Subcutaneously.*—A tenotomy knife is entered about an inch to the outer side of the foramen, carried below it into the canine fossa, hugging the bone, and then swept upward along the surface of the bone so as to divide the nerve close to the foramen, the lip being drawn downward and forward to make the tissues tense.

2. *Through the Mouth.*—An incision is made in the gingivo-labial fold and the soft parts dissected away from the bone until the nerve is reached and divided. Guérin advises that a small portion of the distal end be excised.

3. *By External Incision.*—The incision may be transverse, oblique, or curved; it is only necessary that its centre should correspond to the foramen. The tissues are divided successively until the bone is reached and the nerve found either by following up one of its branches or by seeking it at its point of emergence.

B. *Resection of the Infra-orbital Portion* (Tillaux[1]). Fig. 98, *C.*—A vertical incision is made along the side of the nose from the lachrymal tubercle or the bony ridge of the nasal process of the superior maxilla, which is continuous with the lower edge of the orbit, down to the ala of the nose. A second horizontal one is then begun at the upper portion of the first and carried outward along the lower margin of the orbit beyond its centre. These incisions should involve all the soft parts down to the bone. The lower flap is dissected up, the nerve found, and a silk ligature thrown around it close to the foramen.

The upper flap is then raised, together with the lower eyelid and eyeball, exposing the floor of the orbit as far back as possible, upon which the infra-orbital canal can be recognized as a grayish line running obliquely backward and inward.

The canal is opened with a knife or chisel, the nerve isolated from the artery, raised from its bed with a small hook, and dissected out as far back as may be considered necessary. It is then divided with curved scissors, and the distal portion drawn out by means of the ligature applied to it in the beginning. The length of the portion removed by Tillaux was six centimetres.

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[1] Traité d'Anat. Topographique, p. 310, and Bull. de la Société de Chirurgie, 1878, p. 413.

Dolbeau[1] divided the nerve with curved scissors on the central side of the branches going to the spheno-palatine ganglion, and tore out the ganglion by drawing upon the nerve.

Malgaigne's Method.—Pass a stout tenotome along the floor of the orbit for nearly an inch in the direction of the nerve; cut transversely with its point through the floor of the orbit, the bone being thin will offer no resistance. This divides both canal and nerve. Expose the nerve at the infra-orbital foramen by a simple transverse incision, seize it with forceps and tear it out of the canal.

The first part of this operation has been modified by Von Langenbeck and Hueter as follows: A strong tenotome with slightly blunted point is entered close below the external palpebral ligament and pushed backward and downward along the outer wall of the orbit until its point is felt to leave the bone and enter the fissure; its edge is then turned forward against the sharp border of the orbital process of the superior maxilla and made to scrape along it as the knife is brought forward.

Lücke's Method.[2]—An incision, beginning one centimetre above the outer angle of the eye and close behind the margin of the orbit, is carried downward and slightly forward across the malar bone, dividing its periosteum; from its lower end a second incision is carried backward and forward, terminating over the outer surface of the zygoma about a quarter of an inch behind its junction with the malar bone. This bone is next divided in the line of the first incision by means of a chain-saw, after preliminary division of the soft parts and periosteum on its under and inner surface with a small knife, and then severed from the zygoma with cutting-pliers. The attachments of the masseter to the intermediate piece are then separated, and the flap of bone and soft parts raised with a sharp hook.

If necessary, some of the anterior fibres of the temporal muscle should now be divided in order to expose the spheno-maxillary fossa thoroughly, the fat occupying the fossa pressed backward with a retractor, and the spheno-maxillary fissure recognized with a probe. The nerve and artery can be distinguished by the difference in their course, the former running downward, outward, and forward, the latter upward, inward, and forward. The nerve is seized with forceps and divided with a tenotome well forward in the fissure, and then again with scissors as near as possible to the foramen rotundum. The flap is then put back, and the wound drained at its lower angle.

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[1] Oral communication.

[2] Deutsche Zeitschrift für Chirurgie, vol. 4, p. 322.

An objection to this method is that, in consequence of its interference with the masseter and temporal muscles, the mouth subsequently cannot be freely opened. Lossen and Braun[1] proposed to avoid this difficulty by leaving the attachments of the masseter untouched and turning the flap downward instead of upward, after making the second incision from the upper end of the first instead of from its lower end, and separating the temporal fascia from the malar bone. Czerny[2] has employed this modification five times with good results.

If wounded vessels cannot be seized and tied, the hemorrhage must be arrested by plugging with antiseptic gauze.

INFERIOR DENTAL NERVE.

This nerve may be divided (A) after its exit from the dental canal, (B) in the canal, (C) before its entrance into the canal. The nerve enters the canal by the inferior dental foramen on the inner side of the ascending ramus of the lower jaw at the level of the crowns of the lower teeth; the canal runs obliquely downward and forward just below the alveoli, and the nerve emerges through the mental foramen which lies midway between the alveolar process and the lower margin of the jaw below the second bicuspid tooth.

A. *At the Mental Foramen.*—An incision is made in the gingivo-labial fold above the foramen, and the soft parts dissected off until the nerve is reached, usually about one-third of an inch below the bottom of the fold.

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[1] Centralblatt für Chirurgie, 1878, pp. 65 and 148.
[2] Ibid., 1882, p. 249.

B. *Within the Canal.*—An incision is made through the skin down to the bone along the course of the nerve in front of the masseter, the periosteum raised, and the canal opened with a chisel or small trephine. After removal of the outer table of the bone the nerve is easily found in the canal and divided.

Or the canal may be opened at two points and the intermediate portion of the nerve excised.

C. *Before its Entry into the Canal.*—1. *From within the mouth.* The mouth being held widely open and the commissure of the lips drawn backward and outward, an incision extending from the last upper to the last lower molar tooth is made one-third of an inch on the inner side of the sharp anterior border of the coronoid process, and carried through the mucous membrane to the tendon of the temporal muscle.

The surgeon passes his finger into the incision and along the inner surface of the bone, between it and the internal pterygoid muscle, until he touches the bony point which marks the orifice of the canal. Passing a blunt hook along the finger, he raises the nerve upon it, isolating it, if possible, from the accompanying artery, and divides it with blunt-pointed scissors or knife. Or, without introducing the finger, the hook may be passed back beyond the nerve, its point constantly in contact with the bone, then rotated inward so as to carry its point across and behind the nerve, and then withdrawn.

2. *Through the cheek.* A curved incision is made around the angle of the jaw or around the lower anterior insertion of the masseter and carried through to the bone along its lower portion; then with elevator and knife the muscle is detached from below upward, and the flap raised with a hook until the level of the inferior dental foramen is reached. The bone is then cut away, with a chisel or small trephine and the nerve exposed and excised.

Or a vertical incision may be made through the skin and fascia, the fibres of the masseter separated and the bone thus exposed. Dr. W. T. Bull tells me he found this method very satisfactory. It caused no facial paralysis, and the wound healed kindly.

BUCCAL NERVE.

The buccal nerve, a branch of the inferior maxillary, is not infrequently the seat of painful and persistent neuralgia. It is best approached through the mouth by the following method:

The surgeon places his finger-nail upon the outer lip of the anterior border of the ascending ramus of the lower jaw at its centre, and divides in front of this border the mucous membrane and the fibres of the buccinator vertically. He then seeks for the nerve, separating the tissues with a director, and divides it.

LINGUAL NERVE.

Division of this nerve may be required for the relief of pain in cases of carcinoma of the tongue.

When the mouth is opened widely the pterygo-maxillary ligament can be readily seen and felt as a prominent fold behind the last lower molar, and the lingual nerve can be felt just below the attachment of the ligament on the inner side of the lower jaw, close to the bone below the last molar tooth.

The tongue should be drawn aside by an assistant, the mucous membrane divided for about an inch parallel to the margin of the alveolar process, beginning at the last molar tooth over the position of the nerve, or, according to Chauvel,[1] one-fifth of an inch from the attachment of the mucous membrane to the side of the tongue. The nerve is then readily found in the submucous tissue, raised upon a hook and divided, or a portion excised.

Moore's Method.—Mr. Moore has employed the following method successfully in five cases. He cuts the nerve about half an inch from the last molar tooth, at a point where it crosses an imaginary line drawn from that tooth to the angle of the jaw. He enters the point of the knife nearly three-quarters of an inch behind and below the tooth, presses it down to the bone and cuts toward the tooth. This necessarily divides the nerve. The projection of the alveolar ridge might protect the nerve from a straight bistoury, and therefore a curved one should be used.

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[1] Précis d'Opérations de Chirurgie, p. 435.

FACIAL NERVE.

This nerve has occasionally been stretched and crushed for the relief of clonic spasms of the corresponding muscles. A semi-lunar incision is made around the lower attachment of the ear with a short liberating incision downward from its centre; the flaps are dissected back, and the nerve exposed by drawing the parotid downward, forward and outward.

TENOTOMY.

Professor Sayre,[1] in answering the question, How are we to determine whether, in any given case, we shall be compelled to resort to tenotomy? lays down the following rule as of universal application:

"Place the part contracted as nearly as possible in its normal position, by means of manual tension gradually applied, and then carefully retain it in that position; while the parts are thus placed upon the stretch, make additional point-pressure with the end of the finger upon the parts thus rendered tense, and if such additional pressure produces *reflex contractions*, that tendon, fascia, or muscle must be divided, and the point at which the reflex spasm is excited (the point at which the pressure is applied) is the point where the operation should be performed."

According to Prof. Sayre, the blade of a tenotomy knife should be one inch long, its shank one and three-quarters, its handle strong and marked in such a way that the surgeon can see at a glance in which direction the edge of the blade is turned. The blade may be straight or curved, it should be thick at the heel, very narrow, and the point should be somewhat rounded and sharpened from side to side like a wedge or chisel.

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[1] Orthopedic Surgery and Diseases of the Joints, N. Y., 1876, p. 27.

A fold of skin should be pinched up at the side of the tendon, and the knife entered at its base, so that a continuous track will not be left on its withdrawal. A preliminary puncture may be made with a sharp-pointed knife or lancet to facilitate the entry of the tentome.

The knife must be entered "on the flat" and passed either under the tendon or between it and the skin; its edge is then turned toward the tendon and the division effected with gentle sawing movements, the thumb being pressed firmly against the tendon if the knife has been passed under it.

During the entry of the knife and the division of the tendon, the latter must be kept firmly upon the stretch, and as soon as the division is complete the knife must be turned upon its side and withdrawn, while the surgeon follows its point with his thumb or finger so as to force out any blood that may be in its track and to prevent the entrance of air.

Seal the wound with plaster or collodion, and *then* bring the member into the desired position.

Tendo Achillis.—The knife should be entered on the inner side of the tendon near its border, about one inch above the upper surface of the calcaneum. In this way the posterior tibial artery, which lies between the tendon and the inner malleolus and below the deep fascia, is secured from injury. The heel must be depressed as much as possible, so as to make the tendon more prominent, and give additional security to the artery.

Tibialis Posticus.—The tendon of this muscle may be divided (A) above the malleolus, or (B) on the side of the foot just behind its insertion into the scaphoid.

A. *Above the Malleolus.*—The muscle is made tense by everting the foot; the knife is entered at the inner side of the tendon and passed behind it.

B. *On the Side of the Foot.*—Same position given to the foot. The knife should be directed from above downward, and passed under the upper border of the tendon at a point half an inch below and in front of the tip of the malleolus. Bell[1] prefers to cut toward the bone.

Tibialis Anticus.—Can be easily made prominent and isolated.

Peronei.—May be divided at the posterior face of the lower end of the fibula, or on the side of the foot below and in front of the tip of the outer malleolus.

Flexor Tendons at the Knees.—It must be remembered that the external popliteal nerve accompanies the tendon of the biceps closely, lying upon its inner side.

Sterno-cleido-mastoid.—The danger to be avoided in this operation is that of injury to the external jugular vein at the outer border of the muscle, or to the anterior jugular vein at its inner border. The first can usually be seen under the skin and avoided, the other leaves the muscle about three-quarters of an inch above the sternum and passes backward. The muscle should be divided about half an inch above the top of the sternum, and most authorities agree in preferring to divide from before backward. The knife should be entered at the outer border of the muscle.

Levator Palpebræ.—In a case of paralysis of the orbicularis palpebrarum followed by retraction of the levator palpebræ with inability to close the eye, and subsequent ulceration of the cornea, Professor Detmold divided the latter muscle at its attachment to the upper edge of the tarsal cartilage. The result was very good.

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[1] Manual of Surgical Operations, 3d edition, p. 288.

PART VI.

PLASTIC OPERATIONS ON THE FACE.

PLASTIC operations are required for the relief of congenital defects, or for the restoration of parts lost by disease or injury. The methods most commonly employed are of two kinds:

1. *By Approximation of the Edges.*—This is applicable to cases in which the loss of tissue is not great, and the adjoining parts are supple. The edges of the gap are simply pared and brought together. It is sometimes necessary to make "liberating incisions" on one or both sides for the relief of tension.

2. *By Transfer of a Flap.*—A flap of suitable shape and size is dissected up and transferred, by turning it about its base, to the place where it is needed, its vitality being insured by the preservation of its base or pedicle. This method admits of a great variety of modifications in its details, from a simple sliding of a skin-flap, which differs but slightly from the method by approximation, to the transfer of skin, muscle, and bone or the taking of the flap from another limb or individual.

The names *Indian*, *Italian*, *French*, and *German methods* have been given to the different varieties, but Verneuil[1] has pointed out the impropriety of continuing to employ them, especially since at least two of them, the *French* and *German*, have their origin in an over-sensitive patriotism, not mindful enough of the actual facts. The Indian and Italian methods were first employed for the restoration of the nose; in the former, a flap was taken from the forehead and brought down by twisting the pedicle which occupied the space between the eyebrows. The term is now applied to any operation in which the flap is made with a long pedicle situated at some distance from the space which the flap is to cover, and in which also the flap is brought into place by rotation over a greater or less arc described about the base of the pedicle as a centre (see Fig. 127).

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[1] Mémoires de Chirurgie, vol. i. Chirurgie Réparatrice, p. 401.

In the *Italian method* the flap is taken from a distant part of the body, as in restoration of the nose by a flap taken from the arm (Fig. 129). Tagliacozzi, of Bologna, the originator of this method, allowed the flap to suppurate for a few days, so as to increase its thickness, before fastening it in its new situation. Graefe sought for primary union, and gave, rather pompously, the name *German method* to this modification, ignorant of the fact that it had been suggested more than a century before by Reneaulme de la Garanne, and unmindful of the other fact that it contained no new principle, and must have been entertained by Tagliacozzi, and only rejected for the sake of another advantage incompatible with it.

In the so-called *French method*, the principles of which are found in Celsus, the flap has a broad base, and is brought into place, not by rotation, but by traction in the direction of its axis (Figs. 110 and 122). The variations and combinations of these methods are now so numerous, that the names no longer have much descriptive value.

General Principles.—The edges of the flaps must be brought together without tension, and united very accurately by means of fine silk, catgut, or silver sutures; and it is well to cut the edges obliquely so as to have a broader surface of contact as proposed, I believe, by Dr. Packard.

All hemorrhage must cease before the flaps are brought into place. The presence of a clot of blood under a transferred flap is one of the most common causes of failure.

Flaps must be taken from healthy non-cicatricial skin, and whenever the skin is thin and not very vascular, the subcutaneous layer should be taken with it to insure its vitality.

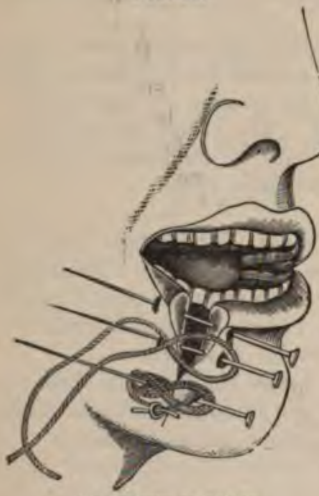
The base of a flap should occupy the quarter from which the main supply of blood is received, and the direction and shape of the flap should be such that it can be brought into place with the least amount of twisting of the base.

The flap should be made considerably larger than the space it is to fill, and, to insure accuracy, it is well to cut it according to a pattern previously made of paper or oil silk. It is well also to mark the angles by fine pins planted erect in the skin.

The raw surface left by the dissection of a flap may be partly covered by drawing its edges together with sutures; the remainder must be left to granulate. Dr. Gurdon Buck[1] recommended a dressing for it which he calls the "collodion crust;" it is made by covering the surface with dry scraped lint, and then with an additional layer of lint saturated with collodion.

The antiseptic method should be employed, as far as possible, to prevent or diminish suppuration, and thereby restrict the formation of cicatricial tissue. With its aid greater tension can be made with the sutures than would otherwise be safe, and the chance of the occurrence of erysipelas becomes less.

FIG. 99.



Cheiloplasty, V-incision.

CHEILOPLASTY.

A. *Lower Lip.*—Restoration of the lower lip is usually undertaken to make good the loss of substance occasioned by the removal of an epithelial tumor. The choice of a method depends upon the extent of the disease.

1. **V**-*Incision* (Fig. 99).—When the tumor is small, involving not more than one-quarter or one-third of the lip, it may be removed by a **V**-incision, and the sides of the gap brought together with one or two points of twisted suture. The mucous membrane on the inside of the lip should be excised to the same extent as the skin, although it is not usually involved in the disease.

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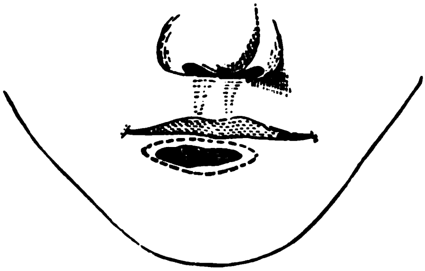
[1] Reparative Surgery, 1876, p. 13.

If not removed it forms a disagreeable fold or pucker in the lip.

The harelip pins must be deeply placed, passing close to the mucous membrane on the inside. This insures confrontation of the raw surfaces throughout their entire breadth, and the pressure of the twisted sutures prevents hemorrhage.

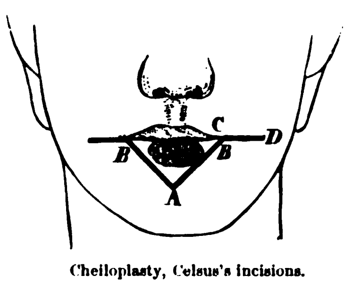
FIG. 100.



Oval horizontal incision.

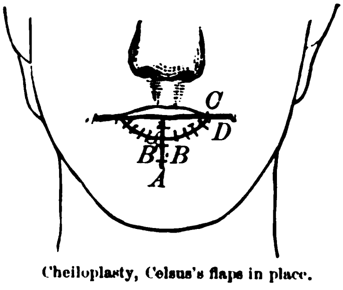
2. *Oval Horizontal Incision* (Fig. 100).—When the tumor covers a considerable extent of surface, but does not penetrate deeply, it may be safely excised by cutting under it with curved scissors. The mucous membrane and skin may then be stitched together, or the wound allowed to heal by granulation.

FIG. 101.



Cheiloplasty, Celsus's incisions.

FIG. 102.

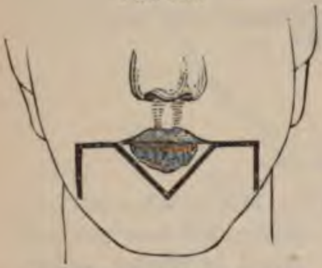


Cheiloplasty, Celsus's flaps in place.

3. *Method of Celsus or Serres* (Figs. 101 and 102).—The V-incision is supplemented by a horizontal one on each side carried outward from the angle of the mouth for about two inches, and comprising the whole thickness of the cheek for

the first two-thirds of its length, but dividing the mucous membrane at a somewhat higher level than the skin. The lower gingivo-labial fold is divided close to the gum on both sides, and the dissection carried downward close to the periosteum, and backward toward the angle of the jaw until the edges of the gap in the lip can be brought together without tension. The sides of the **V** are then brought together, and the lip formed from the lower parts of the horizontal incisions (Fig. 102). The mucous membrane and skin are stitched together along the edge of the new lip, and the remaining portion of the lower flap on each side (that which remains external to the new angle of the mouth) is reunited to the upper flap. The mucous membrane at the outer end of the horizontal incision is stitched to the skin and covers the angle.

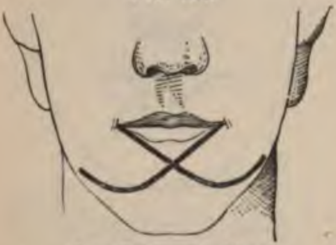
FIG. 103.



Cheiloplasty, Dieffenbach's method.

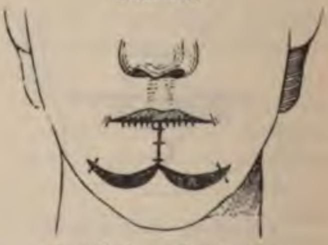
4. *Dieffenbach* (Fig. 103) adds a vertical incision at the end of each horizontal one, thus marking out two quadrilateral flaps which are brought together in the median line. The gaps left in the cheek by the transfer are allowed to close by granulation.

FIG. 104.



Syme-Buchanan incisions.

FIG. 105.



Syme-Buchanan flaps in place.

5. *Syme-Buchanan* (Figs. 104 and 105).—The method by latero-inferior flaps is ascribed by some to Syme, by others to Buchanan, of Glasgow.

After the tumor has been removed by the usual **V**-incision, the incisions are prolonged downward and outward for nearly an inch, and then curved upward and outward. These flaps are dissected off the bone and brought together in the median line. The mucous membrane and skin are stitched together along the upper edge, the gaps left below by the shifting of the flaps drawn together as much as possible, and the remainder left to heal by granulation.

Ranke and *Trélat* (Figs. 106 and 107) make the flap on one side longer and lift it over the other to form the new lip the shorter flap being used as a support for the former.

FIG. 106.

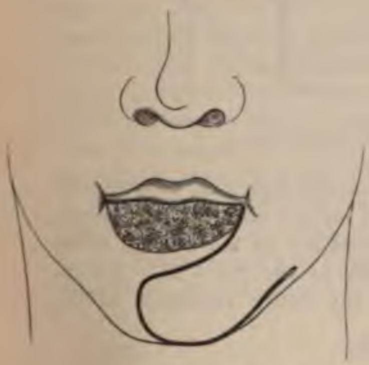
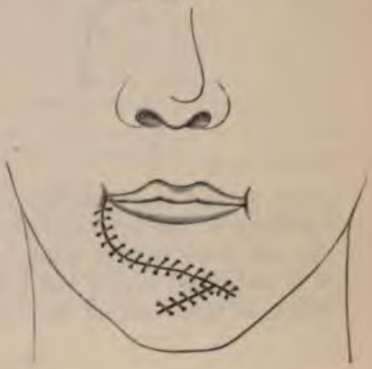


FIG. 107.



6. *Buck's Method* (Figs. 108 and 109).—Buck preferred to make two operations. He first removed the tumor by the **V**-incision, brought the sides of the gap together, and allowed them to unite. After the union had become complete he restored the angle of the mouth and lengthened the lower lip with material taken from the upper one by the following method.[1]

In Fig. 108, *B B* represent two pins inserted a finger's breadth below the under lip border, one on either side of the chin, a little to the outside of the angle of the mouth, and equidistant from the median line; *D D* are also two pins inserted, one on either side, into the upper lip at the margin of the vermilion border, equidistant from the median line, and at such distance apart as to include between them sufficient length of lip border for a new upper lip. The steps of the operation are then the following: With the forefinger of the left hand placed on the inside of the mouth, the left cheek is to be kept moderately on the stretch while it is transfixed with a sharp knife at the point *B*. An incision is then carried through the entire thickness of the cheek, upward and a little outward, a distance of one inch and a half to a point *E*, near the middle of the cheek. The corresponding side of the upper lip should next be trans-

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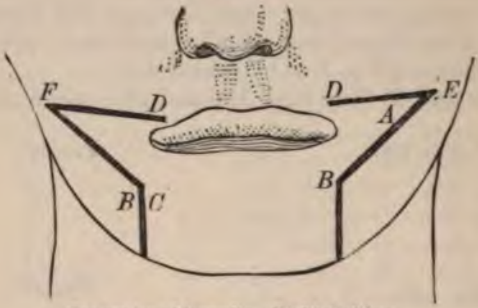
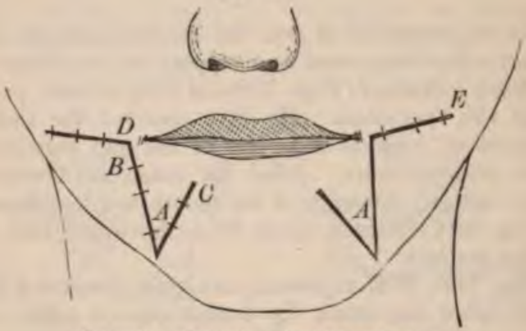
[1] Reparative Surgery, 1876, p. 22 et seq.

FIG. 108.



Restoration of lower lip. Buck's incisions.

FIG. 109.



Restoration of lower lip Buck's flaps in place.

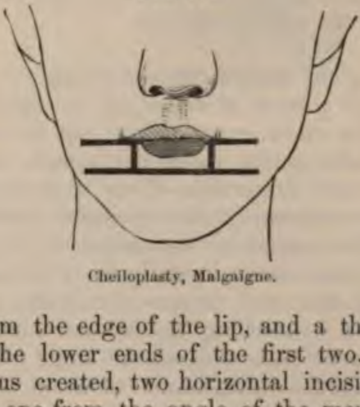
fixed at the point *D*, and the incision carried through the lip and cheek outward and a little upward to join the first incision at *E*.

The next step is to transfer the triangular patch, thus marked out, from the cheek to the side of the chin. For this purpose an incision should be made on the side of the chin from *B* vertically downward to the edge of the jaw and to the depth of the periosteum. The edges of this incision retracting wide apart, afford a **V**-shaped space for the lodgement of the triangular patch, which is now brought around edgewise, and adjusted by sutures in its new position (see Fig. 109). The gap left in the cheek is closed by bringing its edges together and securing them in contact by sutures. By this adjustment a new and naturally shaped angle is formed for the mouth at the point *D*. The incisions should be made with the utmost precision, and special care should be taken that the lining mucous membrane is divided exactly to the same extent as the skin.

The same procedure may be applied to the other side of the mouth, and executed at the same operation.

7. *Square Lateral Flaps*, Malgaigne (Fig. 110).—The tumor is circumscribed by two vertical incisions carried downward from the edge of the lip, and a third horizontal one uniting the lower ends of the first two. To fill the square gap thus created, two horizontal incisions are made on each side, one from the angle of the mouth, the other from the lower corner of the gap. The flaps circumscribed by these incisions are brought forward and united in the

FIG. 110.

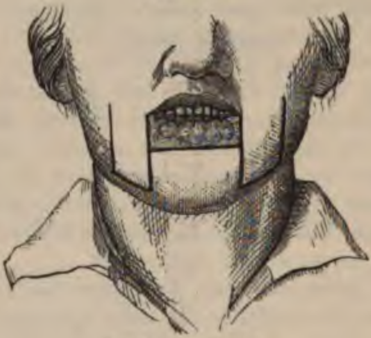


Cheiloplasty, Malgaigne.

median line, and the mucous membrane stitched to the skin along the edge of the lip and at the commissures. (See also 3. *Method of Celsus*, p. 225, and *Stomatoplasty*, v. inf.)

8. *Square Vertical Flaps* (Fig. 111).—Sédillot made the flap at right angles to the line of the mouth. The incisions are shown in Fig. 111. Each flap is swung around to meet the other in the median line, its inner vertical border becoming the edge of the lip.

FIG. 111.

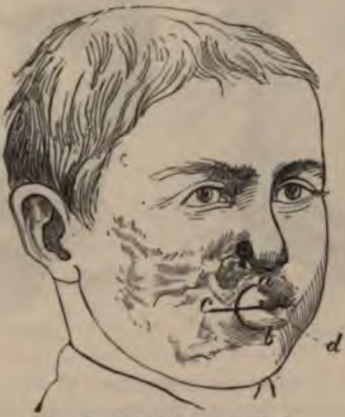


Cheiloplasty, Sédillot.

B. *Angle of the Mouth* (*Stomatoplasty*).—An attempt to restore a large portion of either lip by means of material taken from the other, or to close a gap by simple approximation not infrequently leaves the mouth small, rounded, and pouting, with obliteration of one or both angles. This defect can be overcome by the operation described on page 227, as Buck's method of restoration of the lower lip, or by extending the mouth laterally by a horizontal incision involving both skin and mucous membrane, and then preventing reunion by stitching the skin and mucous membrane together on both sides and at the angle of the incision. Sédillot considers it indispensable to excise a portion of the skin so as to have a comparative excess of mucous membrane which when stitched to the skin will roll outward and form a vermilion border. This simple method has been modified by Dr. Buck as follows:

Buck's Operation[1] *for Enlargement of the Mouth and Restoration of its Angle.* (Fig. 112.)—An incision is made with great exactness along the line of the vermilion border circumscribing the circular half of the mouth, and extending to an equal distance on the upper and lower lips (*a* to *b*). This incision should only divide the skin, without involving the mucous membrane. A sharp-pointed, double-edged knife should then be inserted at the middle of this curved incision, and directed flatwise toward the cheek, between the skin and mucous membrane, so as to separate them from each other as far as the new angle of the mouth requires to be extended. The skin alone is next divided from the commissure of the mouth outward toward the cheek. The underlying mucous membrane is then divided in the same line, but not so far outward. The angles at the outer ends of the two incisions are then accurately united by a single thread suture. The fresh-cut edges of skin and mucous membrane above and below, that are to form the new lip borders, are shaped by paring first the skin and

FIG. 112.



Lengthening of the mouth, Buck.

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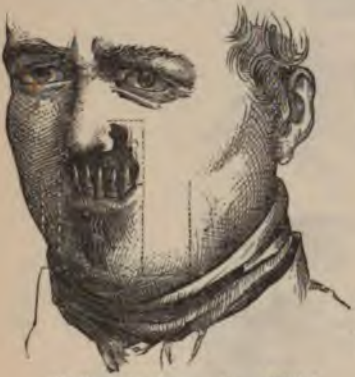
[1] Reparative Surgery, p. 28, et seq.

then the mucous membrane in such a manner that the latter shall overlap the former, after they have been secured together by fine thread sutures inserted at short intervals.

C. *Upper Lip.*—The **V**-incision and the oval horizontal incision (p. 225) may be used when the loss of tissue will be small. Also the square lateral flaps (p. 229) when the gap to be filled is in the centre of the lip and rather large.

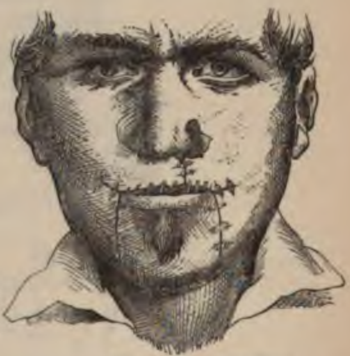
1. *Vertical Flaps* (Figs. 113 and 114).—These may be made with the base directed upward (Sédillot), or downward (Chauvel). Chauvel claims that the latter method is to be preferred because the retraction of the cicatrix in the former tends to draw the new lip upward and expose the teeth.

FIG. 113.



Cheiloplasty of upper lip. Sédillot.

FIG. 114.



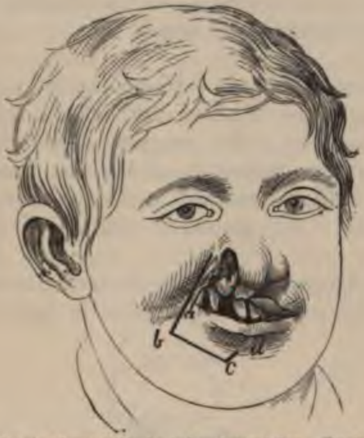
Sédillot Flaps in place.

The flaps comprise the entire thickness of the cheek, are turned inward at right angles to their former position and united in the median line. The gaps left in the cheek by their removal are brought together with sutures or left to granulate.

2. *Infero-lateral Flap* (Buck). Fig. 115.—For loss of the right half of the upper lip Dr. Buck employed the following method, enlarging the mouth afterward and reëstablishing the angle by the method described above (p. 231).

The extremity of the under lip, where it joined the right cheek, was divided through its entire thickness at right angles to its border, and the division carried to the extent of one inch from the border (*a* to *b*, Fig. 115). A second incision was made from the terminus of the first parallel to the lip border for a distance of one inch and a half toward the chin, *b* to *c*. The quadrilateral flap thus formed from the under lip was folded edgewise upon itself, and made to meet the remaining half of the upper lip, and be adjusted to it by its free extremity. In order, however, to make this fold, the under lip had first to be divided obliquely half across its base, *c* to *d*.

FIG. 115.



Repair of upper lip by infero-lateral flap. Buck.

The left half of the upper lip was prepared for the new adjustment by dividing the buccal mucous membrane close to the jaw and detaching the parts above toward the orbit from the underlying periosteum, and secondly by paring a strip of vermilion border from the extremity of the half-lip of sufficient length to permit the end of the half-lip to be matched to the free extremity of the under-lip flap. The parts concerned having been thus prepared, the under-lip flap was doubled edgewise upon itself, and its free extremity adjusted to the half of the upper lip, and the two secured to each other in a vertical line below the columna nasi by sutures. The space between the newly adjusted half of the mouth and the neighboring cheek was closed by approximating the opposite parts and securing them to each other by sutures after their edges had been carefully matched. (Fig. 112 shows the result of this operation.)

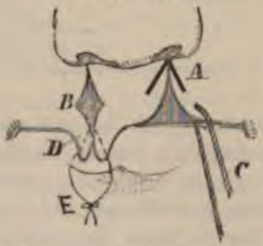
HARELIP.

If the patient is a young child its arms should be securely bound to its sides with a towel, and its head firmly held by an assistant. After anæsthesia has been obtained it can be easily kept up by applying to the nostrils from time to time sponges saturated with ether.

Single Harelip, Simple.—The simplest method of operating is to pare the sides of the cleft and bring the raw surfaces together by a few sutures. The objection to the method is that the retraction of the scar produces a more or less considerable depression in the free border of the lip. It has therefore been generally abandoned for one of the following.

1. *Double Flaps* (Fig. 116).—In order to hold the parts upon the stretch and insure precision in making the cuts, a stout ligature should be passed through the lip at each angle of the cleft, or each angle should be seized with artery forceps. The lip being drawn forward and downward by means of the ligature or forceps, the mucous membrane is

FIG. 116.



Simple single harelip, double flaps. *A* Incisions. *B.* Flaps turned down. *C.* Ligature for holding lip tense *D* Incisions to shorten and adjust flaps. *E* Thread passed through the ends of the flaps.

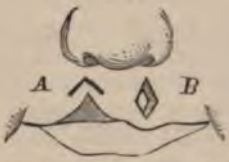
divided close to the gum and the dissection carried upward and backward as far as may be necessary to allow the sides of the cleft to be brought together without tension.

Then making one side of the cleft tense, by drawing upon its ligature, the lip is transfixed near the angle, and the incision carried upward along the border of the cleft to its top, or, if necessary, into the nostril, thus cutting out a narrow flap which remains attached at its lower extremity to the lip (Fig. 116, *A*). A similar flap is then made upon the other side, the two are turned down, so that their raw surfaces face each other, and a thread passed through their free ends (Fig. 116, *E*).

The freshened edges of the cleft are then confronted, a harelip pin placed near the vermilion border and another near the nostril, and two or three fine silk or silver sutures inserted between them. The ends of the dependent flaps are then cut off obliquely, enough being left to form a distinct projection on the lip after they have been united with fine sutures. By this means the formation of a notch by the retraction of the cicatrix is avoided.

2. When the cleft was shallow, Nélaton left the flaps attached to each other at the apex, turned them down, and brought the raw surfaces together as above described (Fig. 117).

FIG. 117.

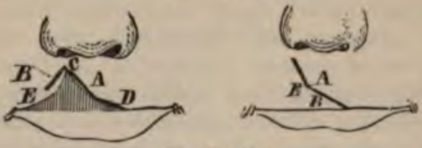


Harelip, Nélaton's method. *A*. Incision. *B*. Flap turned down.

3. *Single Flap* (Fig. 118).—A flap is made upon one side only, usually the shorter portion of the lip. The opposite side of the cleft, and a portion of the free border of the lip adjoining it, are freshened by the removal of a strip of skin and mucous membrane. The sides of the cleft are approximated, and the flap applied to the free border of the lip.

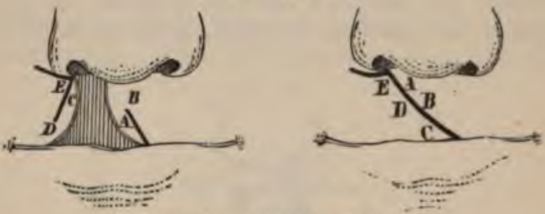
4. *Giraldes's Method* (Fig. 119).—This is applicable only when the cleft extends into the nostril. The flap on the short side is made, as before described, with its base below; that on the long side is reversed, being left attached at its upper end. A third, horizontal incision is carried outward from the edge of the nostril, at the point of the first flap, to make that portion of the lip more movable. The second flap is then turned upward across the nostril, the first brought down to take its place, and the two raw surfaces thus brought into contact united by sutures. The long side of the lip may also be mobilized, if desirable, by a horizontal incision running from the gap close below the columna and the corresponding nostril.

FIG. 118.



Harelip. Single flap.

FIG. 119.

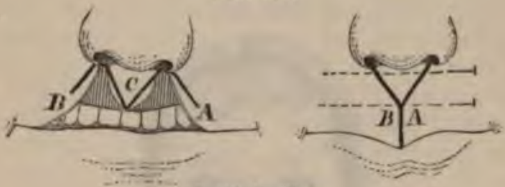


Harelip. Giraldes's method.

Double Harelip, Simple (Fig. 120).—Flaps are made upon the lateral portions, *A* and *B*, as before described (p. 234, 1), and the sides of the central portion, *C*, are pared. The flaps are then brought together, as shown in the figure, after mobilizing the lip by free division of the gingivo-labial fold and carrying the dissection well upward and outward, pins passed to include the sides and the central portion at the base and apex of the latter, the flaps trimmed (p. 235), and united with fine sutures.

If the parts are too scanty to permit the use of this method, liberating incisions must be made around the alæ nasi, or flaps obtained from the cheek. (See *Upper Lip*, p. 232, *et seq.*)

FIG. 120.



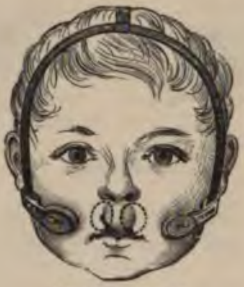
Double harelip.

Complicated Harelip.—Harelip may be complicated by fissure of the palate and alveolar process. When the *fissure is single* the bone on the long side of the lip projects beyond its proper line. In very young children, it may sometimes be forced back into place by making pressure upon it with the thumb, but it is easier to fracture it first with Butcher's pliers; the bent blade of this instrument being applied upon the anterior surface near the further nostril. The two portions of the alveolar arch soon unite after they have been brought into contact, especially if the opposing surfaces have been pared. Sutures are not needed.

When there is *double fissure*, the intermediate portion of bone containing the incisor teeth projects so far that it seems to be an appendage of the nose rather than of the mouth. In order to restore it to its place, it is necessary to divide the vomer with strong scissors, or, better, to cut a triangular piece out of the septum of the nose. It is not necessary to fasten the bones together with sutures. The portion of skin covering the projecting bone must be dissected off, and used to lengthen the columna nasi or fill out the lip.

In extreme cases it may be proper to cut away the projection entirely; but whenever it can be saved and brought into line, it renders valuable service by giving the upper jaw its proper length, and furnishing a space into which artificial teeth can be fitted. The three or four teeth which are found in this piece are always so defective and irregularly placed that they have to be drawn.

FIG. 121.



Cheek compressor.

It is sometimes desirable to take the strain off the sutures by means of a cheek compressor, similar to that represented in Fig. 121.

For uranoplasty, etc., see Operations upon the Mouth.

RHINOPLASTY.

The different kinds of rhinoplastic operations may be classified according to the nature and extent of the loss which they are designed to repair: 1st. A superficial loss not involving the bones or septum. 2d. Loss of the septum and nasal bones, the skin remaining entire. 3d. Loss of more or less of the surface and septum.

As the loss of tissue is always the result of injury or disease, it presents so many variations in form and extent, that it is difficult in practice to determine the exact boundaries between the classes, and this classification is chosen for convenience of description, and not with the intention of limiting the choice of an operation in any given case to those described in the class to which the lesion might belong. For the same reason, a description of an operation as actually performed will sometimes be more serviceable than any general rules that might be laid down.

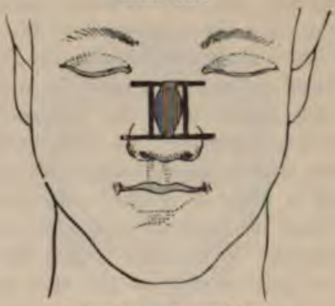
As may be readily understood, the existence or non-existence of the septum and nasal bones affects materially, not only the method of operating, but also the result. If unsupported centrally, the new member tends constantly to shrink and flatten, and the surgeon has the mortification of seeing that he has merely substituted one deformity for another. Ollier tried to meet this want by including the periosteum in the flap taken from the forehead by the Indian method. There was, however, no new formation of bone, and the operation in that respect was a failure. On another occasion he took a strip of healthy periosteum from one of the limbs, and tried to graft it under the skin of the forehead, hoping thereby to procure a lamella of bone, which could be used to give solidity to the new nose. Thinking the graft had failed, he withdrew the strip of periosteum after a few days, and then discovered that it had united nicely at one point. There is reason, therefore, to think that a more patient repetition of the experiment might be successful. On a third occasion, he included the periosteum of the forehead in a flap transferred by a modification of the French method, and by folding it together longitudinally along the centre he got reproductiou of bone where the two layers faced each other.

1. *Superficial Defect not Involving the Bones or Septum.*—If the loss of tissue is confined to the integument, that is, if the cartilage is spared, as it usually is in cases of epithelioma, no plastic operation should be undertaken. The tumor must be carefully dissected off, and the wound left to granulate. The slight mobility of the integument of the region prevents deformity by cicatricial retraction, and the wound heals over, leaving a scar which does not contrast offensively with the neighboring skin.

If, on the other hand, there is a gap to be filled, one that is small and does not involve the free border of the ala, square lateral flaps may be made by horizontal incisions (Fig. 122), and drawn together after they have been rendered freely movable by dissection from the underlying parts.

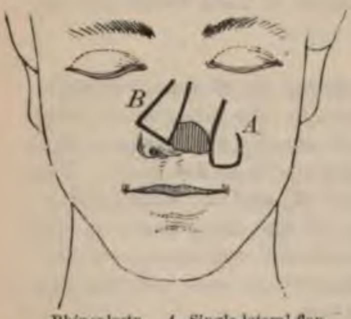
If the gap is larger, or if one of the alæ is lost, suitable oblique or vertical flaps may be taken from the nose or cheek and transferred by rotation. Three of the many variations of this method are shown in Figs. 123 and 124. Fig. 123, *A*, represents a vertical flap taken from the cheek beside and below the nose, and left adherent at its upper end. The flap should be cut long enough to allow a natural appearance to be given to the free border of the ala by turning it in upon itself. This device will also prevent excessive cicatricial contraction of the border and consequent narrowing of the nostril.

Fig. 122.



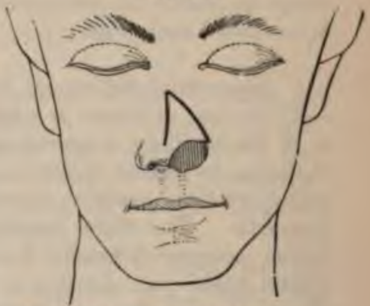
Rhinoplasty. Lateral flaps.

Fig. 123.



Rhinoplasty. *A* Single lateral flap.
B Langenbeck's method.

Fig. 124.



Rhinoplasty. Denonvillier's method.

Denonvillier's Method (Fig. 124) sometimes makes it possible to secure this object more certainly by supplying a border that is already cicatrized. Supposing the lower portion of an ala to be lost, a triangular flap, left adherent to the lobe of the nose, is marked out by an incision which, starting from a point near the lobe on the unaffected side of the median line, is carried directly upward nearly to the root of the nose, and thence obliquely downward to the upper outer corner of the affected ala. The flap is mobilized by careful dissection off the bone and cartilage, and transferred downward. The gap left by the transfer heals by granulation. For the sake of giving more stiffness to the border, Denonvilliers sometimes included a strip of cartilage in it.

Von Langenbeck[1] restored an ala by taking a triangular flap from the opposite side of the nose (Fig. 123, B). The flap was left adherent at the apex of the triangle, which lay near the inner angle of the eye of the affected side, while its base occupied the opposite ala. It was dissected up carefully so as not to include the cartilage, transferred to the other side, and fastened to the freshened edges of the gap. The wound left by the removal of the flap healed by granulation, and so perfectly that it was difficult to recognize there had been any loss of tissue at that point.

Michon restored the ala by taking a triangular flap from the septum. The base of the flap was placed anteriorly, parallel to the ridge of the nose, and the apex lay near the junction of the septum with the floor of the nasal fossa. The flap was dissected up and attached to the margin of the loss of substance, its mucous surface directed outward, its apex made fast to the cheek.

The columna, with or without the tip of the nose, can be restored from the upper lip. Dupuytren and Dieffenbach cut a vertical cutaneous flap, adherent at its upper end, immediately below the columna, turned it upward, twisting it upon its pedicle so that its cutaneous surface remained external, and secured it in place. As the twisting of the pedicle created considerable deformity, Sédillot and Blandin made the flap of the entire thickness and length of the lip, pared off its cutaneous surface, and turned it directly upward without twisting the pedicle, the mucous membrane thus forming the outer surface. The gap left in the lip was then closed with sutures. In Blandin's case the result was excellent, and the mucous membrane gradually assumed the characteristics of ordinary skin; but in Sédillot's case, in which the tip of the nose had also to be restored, the membrane remained red and covered with thick epidermic scales, and the end of the nose looked much like a cherry.[1] In all his rhinoplastic operations Liston made the columna separately by this method, and found that the mucous membrane soon took on the appearance of ordinary integument.

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[1] Essais de Chirurgie Plastique d'après les Préceptes du Prof. B. von Langenbeck, Bruxelles, 1856, quoted by Verneuil.

2. *Loss of the Septum and Nasal Bones, the Skin remaining entire.*—Baron Larrey, about 1820, operated upon a soldier the bridge of whose nose had been shattered and depressed by the explosion of a gun. He removed the deformity by dissecting up the adherent portions of skin and replacing them in their original position. The details of the operation are lacking.

Dieffenbach published in 1829 the description of an operation by which he overcame the great deformity resulting from the loss of the septum and bones of the nose by scrofulous disease. As the case is a classical one, quoted, and often very incorrectly,[2] in the text-books, and is an indication of what may sometimes be accomplished in extreme cases, the following description of it is given.[3]

The patient was a girl twelve years of age. She had lost the ossa nasi, nasal processes of the ethmoid, vomer, and cartilages, and instead of a prominent nose there was a deep pit with a ridge at the bottom. The plan of operation was to divide the remains of the old sunken member into portions, raise them up, and secure them in the proper position. Dieffenbach passed a narrow-bladed knife first into one nostril and then into the other, and cut out, making two incisions, one on each side of the sunken ridge (Fig. 125, *C*). The strip of skin between these incisions was three times as broad at its lower end, where it was connected with the upper lip by the shortened columna, as at its upper part where it joined the forehead. The cheeks were next cut through down to the bones on each side by inserting the knife a few lines below the upper end of the first incision and carrying it obliquely downward, parallel and a little external to the side of the nose, and then around into the nostril, thus separating the lateral attachments of the alæ nasi. The columna being too short, was then elongated by two slight incisions in the upper lip, and the cheeks rendered more movable by dividing their attachments to the bone through the lateral incisions. The flaps were then raised, the sides of the incisions pared obliquely in a manner to which Dieffenbach attaches an importance

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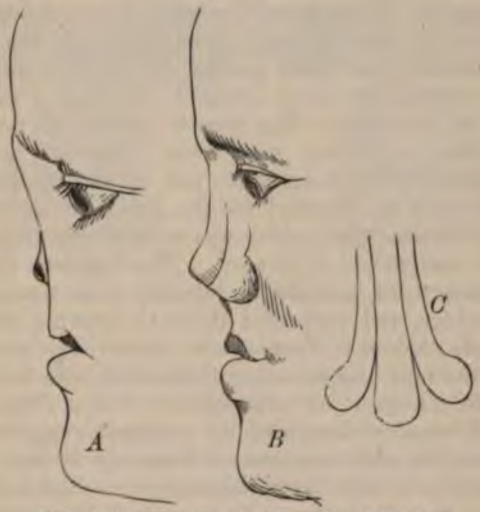
[1] Sédillot, Médecine Opératoire, 2d ed., vol. ii. p. 233.

[2] The description in Holmes's System of Surgery, vol. v. p. 570, is almost unrecognizable. It is taken from Malgaigne's incorrect account, and also contains at least one gross error in translation.

[3] As the original work could not be obtained, this description is made up from an English translation of the book, published in 1833, a French translation of the case in the Gazette Médicale, vol. i. p. 65, 1830, and a brief description with plates, in a collection of Dieffenbach's Plastic Operations, published by two of his pupils in 1846.

FIG. 125.



Dieffenbach's operation. *B*, The result. *C*. The flaps.

that seems undeserved, reunited, and fixed with harelip pins and sutures, and the whole retained in place by drawing the cheeks toward the median line and fastening them there with two long pins passed under the nose and through the detached edges of the cheeks. This compression was aided by two splints of leather through which the pins passed. A quill covered with oiled lint was introduced into each nostril.

Osteoplastic Method.—Ollier treated successfully a somewhat similar case by making a triangular flap, its base constituted by the lower portion of the nose and the adjoining cheeks, its apex situated one and a half inches above the eyebrows. The frontal portion of the flap included the underlying periosteum. The left nasal bone and vomer having been destroyed by the disease, central support could be obtained for the new nose only by aid of the right nasal bone, which was accordingly loosened with a chisel and forçed downward. The flap was then transferred downward, pinched in laterally to increase its height at the bridge, and supported there by drawing the cheeks, previously loosened from their underlying attachments, toward the nose and fastening them there with long pins.[1]

Double Layer, or *Superficial Flaps* (Fig. 126).—Verneuil[2] employed successfully a method suggested to him by Ollier, in which permanent elevation of the bridge of the nose was secured by superposing two flaps and thereby doubling the thickness. The patient had discharged a pistol into his mouth, causing the destruction of a portion of the hard palate and septum, the nasal bones, part of the nasal processes of the superior maxillary, the spine of the frontal, and the anterior wall of the frontal sinuses. The alæ and lobe were uninjured but much flattened; above them was a broad deep groove extending to the middle third of the forehead. The two principal indications were to bring the lateral portions nearer the median line and to reconstitute the bridge of the nose. The latter could be permanently accomplished only by filling in the great cavity which would be left by raising the sunken parts.

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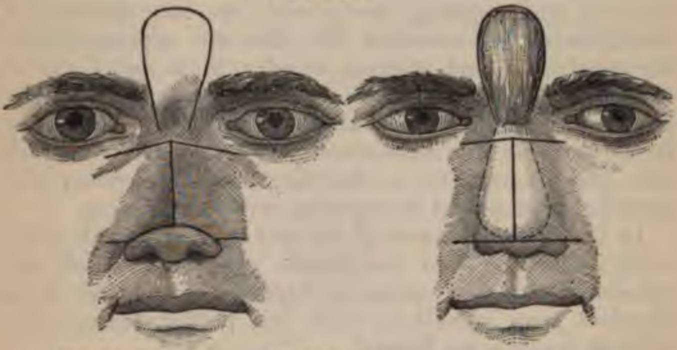
[1] For further details of this operation the reader is referred to the original account in the Bulletin de la Société de Chirurgie, 1862, p. 62, or to its reproduction in Verneuil's Chirurgie Réparatrice, p. 428, and in the Gazette Hebdomadaire, 1862, p. 98, and also to a similar operation described more fully on page 249 of this manual.

[2] Chirurgie Réparatrice, p. 428, and Bull. de la Soc. de Chirurgie, 1862, p. 70.

FIG. 126.



Rhinoplasty, sunken nose. Double layer, or superposed flaps. Verneuil.

Verneuil made an incision along the median line of the depression and a transverse one at each end of the first, and dissected up the two lateral flaps thus marked out. He then raised an oblong flap from the middle of the forehead, its base remaining adherent between the eyebrows, and turned it directly downward so that its raw surface was directed outward, its tegumentary surface toward the nasal fossæ. The two lateral flaps were then placed upon it and united in the median line. The raw surfaces united with each other, and the result was a nose elevated one-third of an inch above the adjoining surface.

Subcutaneous Method.—Prof. Pancoast[1] operated upon a similar case in the winter of 1842–3 by subcutaneous division of the adhesions. The ossa nasi and septum had been entirely destroyed by disease, and the nose was sunken far below the level of the face. "A narrow long-bladed tenotomy knife was introduced on either side by puncture through the skin over the edge of the nasal process of the upper maxillary bone. The knife was pushed up under the skin to the top of the nasal cavity, and then brought down, shaving the inside of the bony wall, so as to detach the adherent and inverted nose upon either side. The point of the nose could now be drawn out. . . . The nose still remained adherent to the top of the nasal chasm. The knife was a third time introduced under the skin in a direction corresponding nearly with the long diameter of the orbits of the eyes and the adhesions separated from the nasal spine and internal angular processes of the os frontis." The soft parts on the cheek were loosened by sweeping the knife outward along the surface of the bone so far as to divide the infra-orbital nerve and artery on each side, drawn toward the median line, and held together with quilled sutures passed through the cavity of the nose.

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[1] Operative Surgery, Phila., 1852, p. 858.

In two weeks the root of the new nose had sunk to the level of the face, but the patient was well satisfied, and refused any further operation, beyond the removal of an elliptical piece of skin to raise this portion again. The ultimate result is not known.

Dubrueil[1] quotes a similar operation by Malgaigne, but without giving the date. As it is not mentioned in the latter's *Médecine Opératoire*, edition of 1837, it is probable that Prof. Pancoast's operation antedates it.

3. *Loss of more or less of the Surface and the Septum.*

A. *Indian Method.*—This method was introduced into Europe in 1814, by Carpue, an English surgeon, and the stimulus given by it to this class of operations was so great during the succeeding twenty-five or thirty years, that this period has been called that of the *renaissance* of rhinoplastic surgery. The ultimate results, however, were not very favorable, and the method has fallen into comparative neglect. It was found that the noses, although sufficiently full, or even excessive at the time of the operation, underwent gradual atrophy, and, when central support was lacking, sank to the level of the cheeks. The nostrils, too, closed sometimes to such an extent, that they would hardly admit a probe; and, finally, the whole flap had a tendency to slide downward, and collect in a lump at the end of the nose after division or excision of the pedicle. The scar left upon the forehead was a serious disfigurement, and the attempt to diminish it by drawing the sides of the gap together gave rise to complications, which endangered the patient's life. The operation itself was not without danger. Dieffenbach lost two out of six patients upon whom he operated in Paris.

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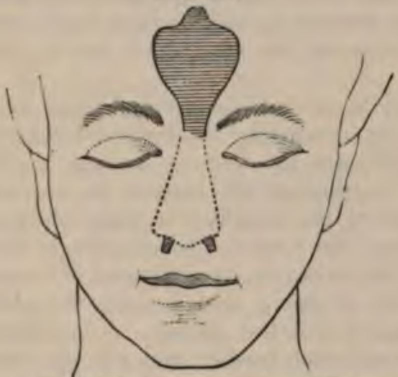
[1] Médecine Opératoire, p. 451.

The operation was originally performed as follows (Fig. 127): A flap, the size and shape of which were determined by a pattern previously made of paper or card, was marked out upon the forehead immediately above the nose. Care was taken to make it at least a quarter of an inch broader and half an inch longer than the space it was to fill. Its base was situated between the eyebrows, and was half an inch broad. At the upper end of the flap was a projecting tab intended to form the columna. The flap, including all the tissues down to, but not through, the periosteum, was then dissected up, brought down by twisting the pedicle, placed in its new position with its raw surface inward, and attached by sutures to the freshened edges of the gap it was to fill. Prominence was given to the ridge by stuffing the nostrils with plugs of oiled lint, or drawing the cheeks toward the median line by means of long pins passed transversely through the edges and under the nose. The gap in the

FIG. 127.



Rhinoplasty. Indian method unmodified.

forehead was left to heal by granulation. After the flap had united, the pedicle was divided, and returned to its original position.

Modifications.[1]—Larrey (1820) pointed out the desirability of saving even the smallest fragments of the original nose, especially if they belonged to the free border of the ala. Prof. Bouisson[2] formulated this principle, and extended it to the other methods, as follows: 1st. Save as much as possible of the septum. 2d. Give lateral support to the flaps by means of the healthy portion of the cartilage of the alæ. 3d. Insure the regularity of the outline of the nostril by giving the lower border of the flap cartilaginous support. Dupuytren and Dieffenbach opposed the retraction and closure of the nostrils by folding back upon itself that portion of the edge of the flap which was to form the free border.

The torsion of the pedicle involves more or less danger of gangrene by obstructing the return of the venous blood. Lisfranc (1826) was the first to attempt to diminish this defect. By lengthening the incision on one side, the base or attachment of the pedicle was made oblique instead of transverse, and the torsion correspondingly diminished at that point. Of course, the total amount of torsion remained the same, but, by being spread along the pedicle, it was made more spiral and less abrupt. Von Langenbeck (before 1856) went a step further, and put the base upon the side of the nose close to the eye, the upper incision ending at the eyebrow, the lower just below the tendo oculi. Labbat did about the same thing in 1827.

Auvert, a Russian surgeon (date unknown, but long before 1850), made the flap oblique instead of vertical, still keeping the base between the eyebrows. Alquié, of Montpellier (1850), proposed to make the flap horizontal, the lower incision being hidden by the eyebrow; and Landreau even curved it somewhat upward at the end, so that the base of the pedicle was hardly twisted at all in bringing down the flap. Ward (1854) made a flap which was directed obliquely upward, and Follin (1856) made a transverse one; in each case the base of the pedicle was upon or near the median line of the forehead, a little above the eyebrows. Both cases did well. The objection to a transverse flap is that the retraction of the cicatrix upon the forehead draws the corresponding eyebrow upward. The advantages are that the torsion is less, and the scar somewhat disguised by the natural lines.

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[1] The dates of these modifications, and the award of credit for their suggestion are mainly taken from Verneuil's *Chirurgie Réparatrice*, to which the reader is referred for further details and documentary proof.

[2] Rhinoplastie latérale.

Various means have been employed to prevent the descent of the flap. Dieffenbach made a longitudinal incision on the side of the nose, and engaged the pedicle in it, paring off its prominences afterward. Blandin excised the portion of skin intermediate between the base of the pedicle and the loss of substance, and thus obtained a raw surface to which the whole length of the pedicle was then united. Instead of excising this intermediate piece of skin, Buck left it attached by its upper end, and used it to cover part of the gap left upon the forehead. Velpeau divided the pedicle close to its base, trimmed it to a point, and engaged it in a vertical incision made in the underlying skin.

B. *Ollier's Osteoplastic Method*[1] (Fig. 128).—A lupus had destroyed the alæ, columna, lobe, cartilages, and part of the septum. The nasal bones were uninjured, but had suffered an arrest of development, and were bounded inferiorly by a strip of cartilage. The nose was not more than an inch long. The skin of the cheeks and lips had also been involved by the lupus, and, therefore, could not be used for the restoration.

Starting from a point in the median line of the forehead two inches above the eyebrows, Ollier made two incisions diverging downward, each of which ended a quarter of an inch to the outer side of the lower border of the nasal orifice.

In dissecting up the long triangular flap thus marked out, he included the periosteum from above downward as far as to the upper end of the nasal bones; he then continued the dissection along the right nasal bone, leaving the periosteum adherent to it, and on reaching the lower end of the bone he separated from it the cartilaginous strip above mentioned, leaving it adherent to the flap.

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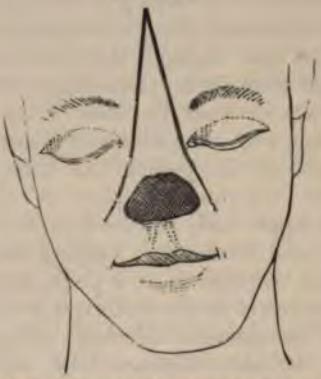
[1] Traité de la Régénération des Os, vol. ii. p. 469.

On the left side he divided, with a chisel, the bony connections of the left nasal bone, leaving the bone attached to the flap by its anterior surface; this was accomplished by introducing the chisel, first between the two nasal bones, then between the left nasal bone and the frontal, and finally between the left nasal bone and the nasal process of the superior maxillary. Drawing the flap downward, he then divided the cartilaginous septum from before backward and downward with scissors, so as to have an antero-posterior flap of cartilage attached by its base to the cutaneous one, and able to furnish central support for the new nose by resting its free border upon the floor of the nasal fossa, or rather upon the remains of the lower portion of the original septum.

FIG. 128.



Rhinoplasty. Ollier's osteoplastic method.

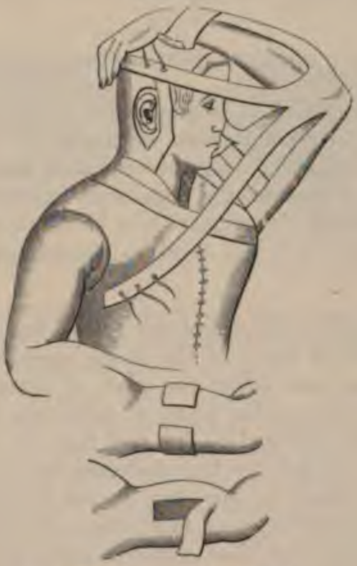
He next drew the whole flap downward until the upper border of the left nasal bone came into line with the lower border of the right nasal bone, and then fastened the two bones together with a metallic suture. The sides of the flap were then united to the cheeks, and those of the frontal incisions drawn together above the apex of the flap.

The parts united, the space left by the removal of the left nasal bone was filled with bone produced by the periosteum brought down from the forehead, and the result was satisfactory.

C. Alquié used a flap of similar shape in a case in which the alæ and septum were lost, but the columna remained. The apex of the triangle was placed in the space between the eyebrows, and the incisions diverged downward and outward. With a narrow tenotome passed along the incisions he separated the skin entirely from the nasal bones and was then able to depress it far enough to attach it to the freshened end of the columna.

D. *Italian Method* (Fig. 129).—Tagliacozzi made two nearly parallel incisions along the anterior surface of the arm, their length and the distance between them varying according to the size of the gap the flap was to fill. The apex of the flap was directed toward the shoulder. The intermediate strip of skin was dissected up, but left adherent at both ends, and a piece of oiled lint passed under it and

FIG. 129.



Rhinoplasty. Italian method.

kept there until suppuration was established. The strip was then cut free at its upper end, and dressed carefully for about a fortnight, or until its under surface was nearly cicatrized. It was then considered fit to be applied, having undergone the necessary shrinking and thickening. Its edges and those of the nasal aperture were pared and fastened together with sutures, and the arm bound fast to the head. When union had taken place between the two, the lower end of the flap was cut loose from the arm and its edges trimmed to the proper shape.

Graefe did not let the flap suppurate, but tried to get primary union.

Dr. Thomas T. Sabine has successfully filled by the implantation of a finger the gap left by the destruction of the nose.

PLASTIC OPERATIONS UPON THE EYELIDS.

In these operations it is important to save as much as possible of the original tissues, especially the free border of the lid, the conjunctiva, and the orbicular muscle. As the skin is thin and delicate, the flaps must have broad bases to insure their vitality; they must also be so placed that their natural retraction will not tend to reëstablish the previous defect.

Blepharoraphy.—Suture of the eyelids has proved a very valuable adjunct of many of the plastic operations upon the eyelids, and has even taken the place of some of them, for experience has shown that a loss of substance in either eyelid may be safely allowed to fill and heal by granulation if the borders of the lids are kept fastened together. The eye must be kept closed in this way for six months or a year, after which time the scar, in most cases, shows no tendency to retract. When the time comes to separate the lids, this should, at first, be done for only half an inch in the centre, and the opening subsequently enlarged at long intervals of time, any indication of cicatricial retraction being meanwhile watched for.

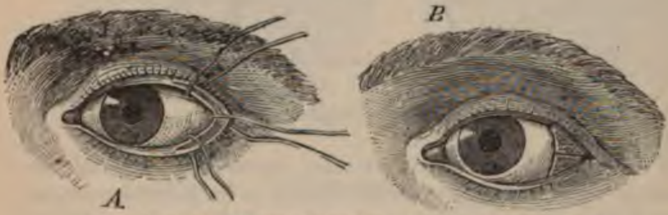
The prolonged occlusion does no harm to the eye; on the contrary, it may be sufficient in itself to cure a commencing keratitis occasioned by ectropion.

Operation.—A narrow strip of conjunctiva is excised from the border of each lid on the conjunctival side of the lashes, beginning and ending a short distance from the commissures, so as to leave a space for the flow of the tears. The two raw surfaces are then brought together accurately with silver sutures.

To separate the lids afterward a director should be entered at the opening left at one of the angles, its point pressed against the centre of the line of union, and cut down upon the two rows of lashes.

Canthoplasty.—Enlargement of the palpebral opening (Fig. 130). The external angle of the eye is divided horizontally with scissors, and the skin and conjunctiva united along the sides of the incision by three points of sutures, one of them being placed at the angle.

FIG. 130.



Canthoplasty. *A.* Straight incision. *B.* Richet's modification.

Richet's modification[1] (Fig. 130, *B*). Richet marks out a small flap by two incisions through the skin, beginning at opposite points on the upper and lower lids near the outer angle and meeting at a point external to that angle. The flap, including everything except the conjunctiva, is then excised, the conjunctiva split horizontally, and its two portions trimmed and fastened to the edge of the cutaneous incisions.

Blepharoplasty, to prevent or remedy—

1. *Ectropion.*—The descriptions will be given for the lower lid only, that being the more frequent seat of the deformity. Blepharoraphy (*q. v.*) is often sufficient in itself

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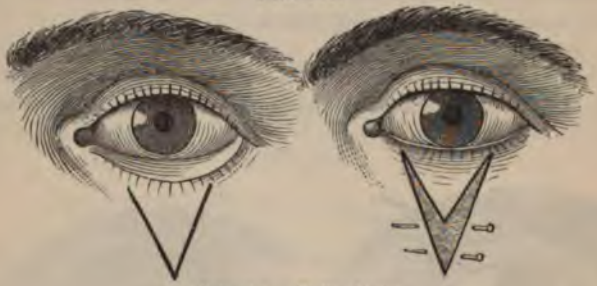
[1] Anatomie Médico-Chirurgicale, 4th edition, p. 88.

to prevent ectropion, and is always a useful adjunct of a plastic operation. The lids should be kept united during the process of cicatrization of the wound left by the loss of substance, and for several months thereafter.

Wharton Jones (Fig. 131).—Wharton Jones included the contracted cicatrix in a triangular flap one inch high, its base occupying nearly the whole length of the lid border. By dividing the bands of cellular tissue, but without dissecting up the flap, he restored the lid to its normal position, and held it there by uniting the edges of the incisions below, thus giving it the form of a **Y**.

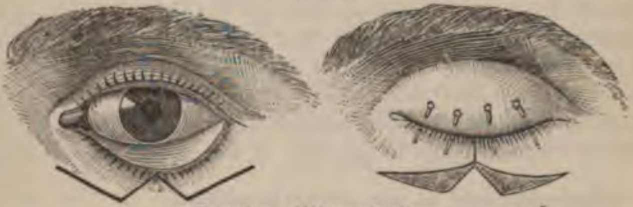
FIG. 131.



Ectropion. Walter Jones.

Alphonse Guérin[1] (Fig. 132) makes two incisions forming an inverted **V**, the point of which lies just below the centre of the free border of the lid. From the lower extremities of these incisions he makes a third and fourth

FIG. 132.



Ectropion. Alphonse Guérin.

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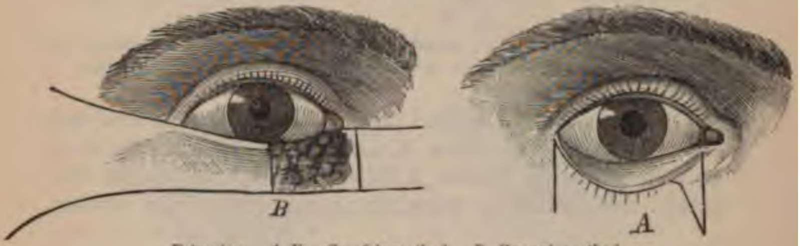
[1] Chirurgie Opératoire, 4th edition, p. 318.

parallel to the border of the lid. The two triangular flaps bounded by the 1st and 3d, and the 2d and 4th incisions are then dissected up, the lid raised to its normal position, and held there by uniting the adjoining sides of these two flaps in such manner that their apices and that of the inverted **V** meet at a common point. The gaps left by the removal of the two flaps are allowed to granulate. For greater security Guérin also unites the borders of the lids (blepharoraphy).

Von Graefe (Fig. 133, *A*).—Make an incision along the border of the lid just outside of the lashes from the lachrymal point to the external commissure. From each extremity of this make a vertical incision downward from one-half to three-quarters of an inch in length. These incisions should involve only the skin. Cut off the upper inner corner of this flap, not by a straight incision, but by one forming an angle, as shown in the figure, and fasten this angle by a suture to that formed by the border of the lid and the inner vertical incision. Reunite the edges of the transverse incision, cutting the ends of the sutures long enough to reach to the forehead, and then fastening them there with adhesive plaster. The excision of the inner angle of the flap raises the eyelid by shortening its border.

FIG. 133.

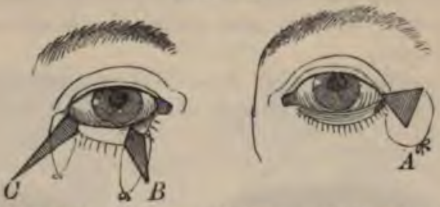


Ectropion. *A*. Von Graefe's method. *B* Knapp's method.

Dieffenbach, *Adams*, and *Ammon* have proposed other methods of shortening the lid. They are indicated in Fig. 134, where the shaded spaces represent the portions of skin to be removed, and the threads the manner in which the edges are afterward brought together. Adams's excision included the whole thickness of the lid.

Richet (Fig. 135).—Richet makes an incision parallel to the border of the lid, half an inch below it, and extending nearly from one angle of the eye to the other. The lid, having been freed by this incision, is then united to the other (blepharoraphy).

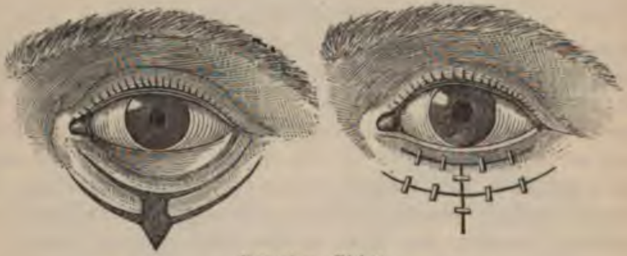
FIG. 134.



Ectropion. *A.* Dieffenbach. *B.* Adams. *C.* Ammon. The shaded spaces indicate the portions of skin removed; the threads show how their edges are brought together.

He next makes a second incision parallel to the first and one-third of an inch below it, divides the intermediate strip of skin vertically in the middle and dissects up its two halves. Immediately below the lower end of this vertical incision he removes from the lower border of the second incision a **V**-shaped flap of skin, its point directed downward. He then raises the two halves of the middle flap, brings them again into contact with the border of the lid, excises their superfluous length, and unites them. The sides of the **V** are then brought together and the edges of the incisions reunited.

FIG. 135.

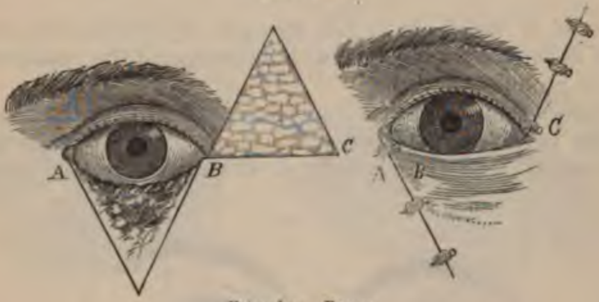


Ectropion. Richet.

Knapp (Fig. 133, *B*).—Knapp employed the following method to remove an epithelioma occupying the inner portion of the lower eyelid, the free border of which was involved. He circumscribed the tumor by two vertical and two horizontal excisions and excised it. The horizontal incisions were then prolonged on both sides, the lower external one being inclined downward so as to make the base of the flap broader, the two flaps dissected up, drawn together and united by their vertical edges.

Burow (Fig. 136).—The loss of substance is made triangular in shape, the apex directed downward; the base is then prolonged horizontally outward, and an equal and similar triangle marked out upon the upper side of the prolongation. The skin contained within the second triangle is then excised, and the irregular flap bounded by the outer sides of the two triangles and the prolongation of the horizontal incision dissected outward and downward, and then moved toward the median line until it covers both the open spaces.

FIG. 136.

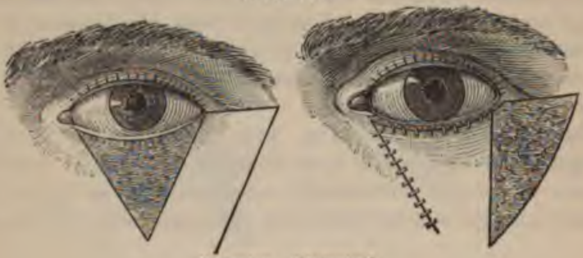


Ectropion. Burow.

It is not necessary that the two triangular spaces should touch at one corner; they may be an inch, or even more, apart; but they must of course be connected by the horizontal incision.

Dieffenbach (Fig. 137).—When the cicatrix or tumor was large Dieffenbach gave the loss of substance a triangular shape, the apex directed downward. He prolonged outward the horizontal incision forming the base of the triangle, and carried another incision downward and inward from its outer extremity. The quadrilateral flap thus marked out was dissected up and carried inward to cover the loss of substance. The gap left by its removal was then drawn partly together with sutures, and the remainder left to granulate.

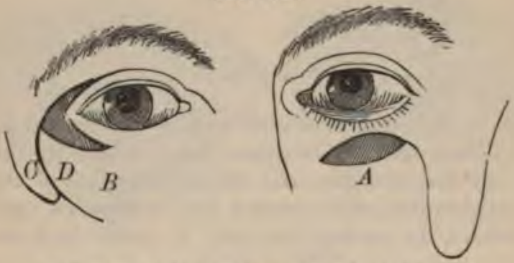
FIG. 137.



Ectropion. Dieffenbach

Indian Method.—Sédillot refers the first blepharoplasty by the Indian method to Von Graefe in 1809. As this was previous to the introduction of rhinoplasty by the same method, the idea was probably entirely original with Von Graefe. The case is mentioned in his *Rhinoplastik*, 1818, but without details. The flap can be taken from the forehead or cheek; it should be very large and should include the subcutaneous cellular tissue. Fricke, of Hamburg, took a vertical flap from the temporal region to restore the upper eyelid.

FIG. 138.



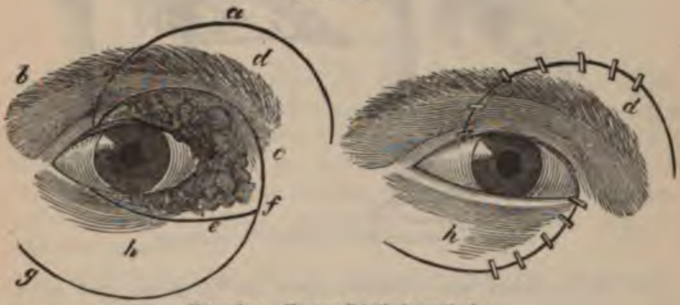
Ectropion. *A.* Modified Indian Method. *B.* Richet.

One of the modifications of this method, intended to obviate the necessity of dividing the pedicle, is shown in Fig. 138, *A*.

Richet (Fig. 138, *B*).—The lids are freed by two incisions inclosing all the cicatricial tissue, and then united (blepharoraphy), the sutures being cut long and their ends fastened upon the forehead. Two flaps are then marked out as shown in the figure, the external one, *C*, raised and used to cover the original loss of substance, and the inner one, *D*, used to fill the gap occasioned by the removal of *C*.

Hasner d'Artha (Fig. 139) employed the following method in a case where a tumor occupied the commissure and inner portion of each eyelid. He made a curved incision, *a*, beginning at the border of the upper eyelid beyond the limit of the tumor, crossing the eyebrow to the forehead, and then crossing downward to terminate near the root of the nose. A second curved incision, *c*, began at the same point as the first and was carried along the upper and inner edge of the tumor to the point marked *f*. A third curved incision, *e*, began on the border of the lower lid beyond the limit of the tumor and was carried along the lower margin of the latter to the point *f*. A fourth curved incision, *g*, parallel to the border of the lower lid, was carried from the point *f* outward to the cheek.

FIG. 139.

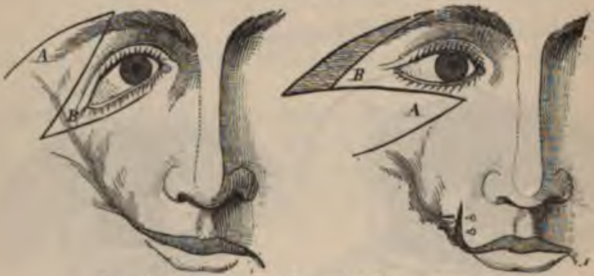


Ectropion. Hasner d'Artha's method.

The tumor and the portion of the lids circumscribed by the incisions *c* and *e* were then removed, and each of the flaps *d* and *h* dissected up to its base. The former was lowered, the latter raised, and the excess of each cut off. The upper border of the flap *h* formed the free border of the lower lid, and the lower border of the flap *d* formed the free border of the upper lid, and the commissure corresponded to the apex of the flap *h*. The skin of the forehead and cheeks was mobilized and reunited to the flaps (Dubrueil).

Denonvilliers's method "by exchange" (Fig. 140). In a case of ectropion of the lower lid, with deviation of the outer angle of the eye downward, Denonvilliers used the following method. By making three incisions to meet in the form of a **Z**, he marked out two adjoining triangular flaps; one of them included the outer angle of the eye, the apex of the other was situated upon the forehead just above the eyebrow. He then dissected up the flaps, restored the angle of the eye to its proper position, brought the upper flap down into the gap made by the lower incision, and the lower flap up into that made by the upper incision.

FIG. 140.



Ectropion. Denonvilliers's method "by exchange."

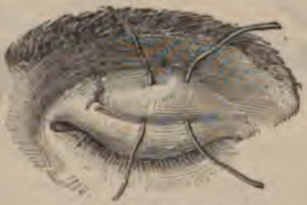
Ectropion due to excess of the conjunctiva may be treated by cauterization of the conjunctiva, or by excision of a portion. The latter operation is simple; a fold is pinched up with forceps and excised with knife or scissors. The edges of the gap may then be brought together by sutures or left to granulate.

2. *Entropion.—Canthoplasty* (*q. v.*) may be employed to remedy moderate entropion, especially if it be due to spasm of the orbicularis.

Ligature (Fig. 141), proposed by Gaillard to remedy trichiasis, is equally applicable to the cure of entropion. A transverse fold is pinched up, and a needle carrying a stout ligature passed through its base, shaving the anterior surface of the cartilage. The ligature is tied and allowed to cut through the skin. The resulting linear cicatrix maintains the lid in the position given it by the ligature.

Rau has modified this by placing several ligatures instead of only one.

FIG. 141.



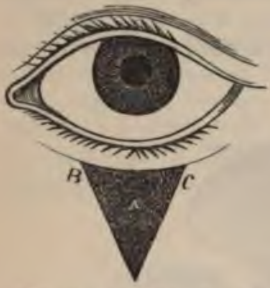
Entropion; ligature.

Excision or cauterization of a fold of the skin is applicable to cases of entropion due to laxity of the skin of the eyelid. A transverse or a vertical fold is pinched up quite near to the margin of the lid and excised; the borders of the wound are united by sutures. Instead of excision, cauterization of the strip, preferably with sulphuric acid, is sometimes used.

Von Graefe (Fig. 142) treated a case of spasmodic entropion by removal of a triangular piece of skin. He made a cutaneous incision parallel to the free border of the lid, and about a line from it, and excised a triangular cutaneous flap, the base of which occupied the median portion of the first incision. The sides of the wound left by the excision of the triangular piece were then drawn together with sutures.

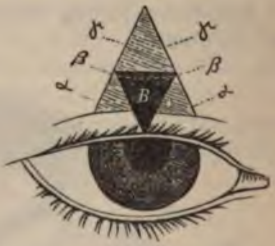
For spasmodic entropion of the upper lid, with retraction of the tarsal cartilage, Von Graefe modified the operation as follows (Fig. 143): After excision of the triangular cutaneous flap, he drew the sides of the wound apart, divided the orbicular muscle horizontally near the edge of the lid, and drew it upward, exposing the cartilage. He then excised a triangular piece of the cartilage, the apex being at its lower border, taking care not to include the conjunctiva in the dissection. The sides of the cutaneous wound were then drawn together with three sutures, the middle one of which included also the sides of the gap left in the cartilage.

FIG. 142.



Entropion—lower lid. Von Graefe.

FIG. 143.



Entropion—upper lid. Von Graefe.

Excision of a Portion of the Orbicularis.—Key cured a case of spasmodic entropion by excising a few fibres of the orbicular muscle. He made an incision through the skin parallel to and near the free border of the lid, exposed the muscle, and removed a bundle of fibres from its central margin. It is well to combine this with removal of a horizontal strip of skin.

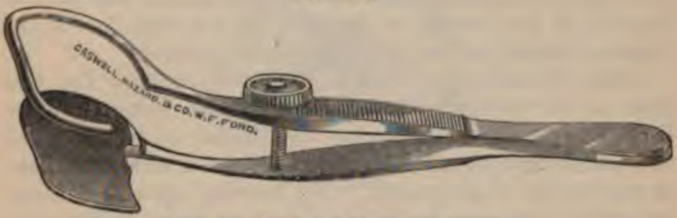
Division or Resection of the Tarsal Cartilage.—When the entropion is caused or maintained by shortening or incurvation of the tarsal cartilage, the operation must be directed to the removal of this cause.

Vertical division at one or two points of the entire thickness of the lid has been employed. After having been divided, the border of the lid is held in its proper position by ligatures passed through it and fastened to the forehead (upper lid) or cheek (lower lid) while the wound fills and heals by granulation.

A horizontal incision through the conjunctiva from one vertical incision to the other makes it easier to turn the lid out and hold it in place.

Longitudinal Tarsotomy (Ammon).—The eyelid having been turned out, a knife is passed through it from the conjunctival side, quarter of an inch from the border, and on a line with the lachrymal point, and an incision made parallel with the border nearly to the outer angle. A longitudinal strip of skin is then excised, and the edges of the gap left by the excision are drawn together. By this means the free border of the lid is drawn away from the surface of the eye, turning upon the longitudinal incision as upon a hinge.

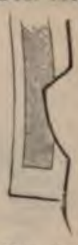
FIG. 144.



Knapp's modification of Desmarres's forceps.

Excision of part of the Cartilage (Streatfeild), (Fig. 145.)—The eyelid is fixed with Desmarres's forceps (Fig. 144), the flat blade against the conjunctiva, and an incision made parallel to the border of the lid at the distance of one line from it, and carried to a depth sufficient to expose the bulbs of the eyelashes. The surgeon, raising the edge of the skin, passes around the bulbs to the tarsal cartilage, and then makes a second incision at a greater distance from the border of the lid than the first one was, meeting the first at its two extremities and inclosing with it an oval strip of skin. These two incisions are carried into the cartilage, circumscribing a longitudinal wedge-shaped strip, the apex of which reaches nearly to the conjunctival side of the cartilage. The wound is left to heal by granulation, with the expectation that the contraction of the cicatrix will overcome the entropion.

FIG. 145.



Entropion. Streatfeild's method.

3. *Symblepharon.*—When the adhesion between the two layers of the conjunctiva is incomplete, that is, when it does not extend to the bottom of the sulcus between the lid and eyeball, it is sufficient to throw a ligature around it. After the ligature has cut through, the tabs are successively

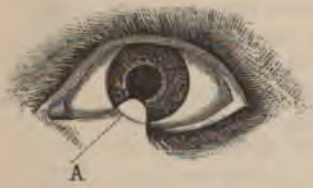
excised, and the borders of each wound drawn together or left to heal by granulation. To avoid reunion of the surfaces, the second tab should not be removed until after the wound left by the removal of the first has healed.

When the adhesion is complete, but not broad, a thread or silver wire may be passed through its base and tied loosely around it. After the hole made by the wire has cicatrized the adhesion is divided. The narrow line of cicatrix left at the bottom of the fold by the wire favors the separate healing of the two sides of the incision.

Arlt's Method.—A thread is passed through the fold close to the cornea, and the symblepharon dissected away from the eyeball. Each end of the thread is then attached to a needle and passed through the lid from within outward at the bottom of the wound. By drawing upon the thread and tying it outside the lid the symblepharon is folded upon itself and its point fixed at the bottom of the sulcus. The edges of the wound on the eyeball are then drawn together with sutures, the conjunctiva being loosened by dissection, if necessary.

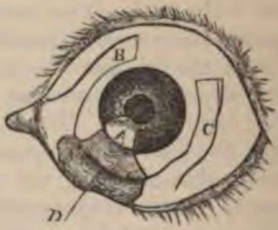
Teale's Method (Figs. 146, 147, 148).—The symblepharon is separated from the ball of the eye by an incision along the line of its union with the cornea and dissected down to the bottom of the fold as in Arlt's operation, its apex, however, being left upon the cornea. Two long, narrow conjunctival flaps, *B* and *C*, are then dissected up on opposite sides of the eyeball, their bases directed toward the symblepharon, their borders parallel to that of the cornea. These flaps should not include the subconjunctival tissue.

FIG. 146.



Symblepharon.

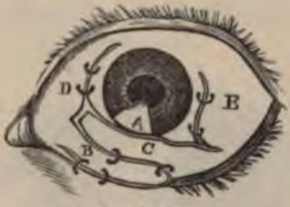
FIG. 147.



B, *C* The flaps

The inner flap *B* is brought down and fastened to the denuded surface of the eyelid, the outer flap *C* covers that of the eyeball. They are fastened in place by means of fine sutures, and the edges of the gaps left by their removal brought together in the same manner.

FIG. 148.



Flaps in place.

Ledentu's Operation.—Where one lid was adherent throughout its entire length, Ledentu divided the adhesion to a depth equal to that of the normal fold, dissected a long conjunctival flap from the other half of the eye, leaving it adherent at both ends, brought it down across the cornea, and applied it to the raw surface left on the eyeball by the division of the adhesion. This flap should be at least one-third of an inch broad.

4. *Pterygion. Excision.*—The pterygion is pinched up with forceps, a knife passed flatwise under it close to the cornea, and the portion of the growth which corresponds to the latter shaved off. The edges of the conjunctival wound are then drawn together with sutures.

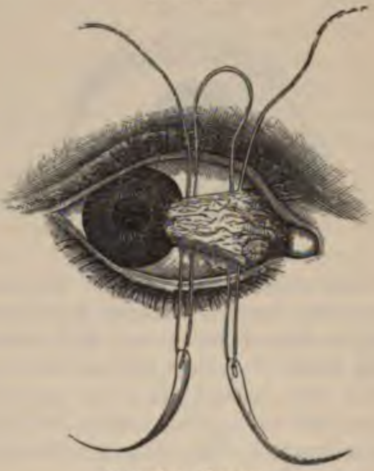
Scissors may be used instead of the knife; in that case the incision must begin at the point of the growth.

Ligature, Szokalski (Fig. 149).—A thread is passed under the pterygion by means of two small curved needles, as shown in Fig. 149. The thread is cut close to the needles, and thus made to furnish three ligatures, one at each end, encircling the growth at right angles to its long axis, and one in the middle, encircling its implantation upon the sclerotic. The ligatures are tied tightly, and the inclosed portion falls in a few days.

5. *Trichiasis.*—Temporary removal of the deviated lashes is seldom effectual. Permanent removal by destruction of

their bulbs, or excision of the border of the lid, is now considered unjustifiable. The direction of the lashes may be changed by operation upon the lid. The retraction following excision of an oval strip of skin, or the use of ligatures as in entropion, is sometimes sufficient, but it may be necessary to act more directly upon the lashes.

FIG. 149.



Pterygion; ligature.

Von Graefe's Method.—An incision is made along the free border of the lid on the conjunctival side of the deviated lashes. From each end of this a vertical incision is next made through the free border and the skin. The flap thus circumscribed and containing the lashes is dissected up a short distance. It is then easy to fasten it with sutures in such a position that the lashes can no longer touch the eyeball.

Anagnostakis made a cutaneous incision parallel to the border of the upper lid and one-eighth of an inch from it, exposed the orbicular muscle by drawing the skin up, and excised that portion of it which corresponded to the upper part of the tarsal cartilage. The lower edge of the cutaneous incision was then drawn up and fixed to the fibrocellular layer covering the cartilage by means of three or four sutures, which were then allowed to cut themselves out.

PART VII.

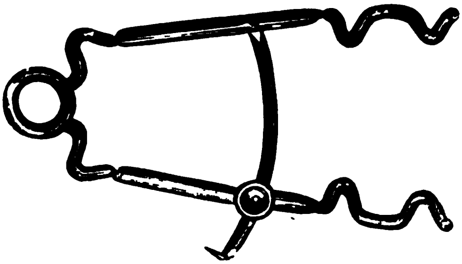
SPECIAL OPERATIONS.

CHAPTER I.

OPERATIONS UPON THE EYE AND ITS APPENDAGES.

In most operations upon the eye the lids should be held back by an eye-speculum (Fig. 150), and the eyeball fixed by pinching up a fold of the conjunctiva with toothed forceps.

Fig. 150.



Eye speculum.

The instillation of a few drops of a four per cent. solution of the hydrochlorate of cocaine under the lids will make most operations painless, but the sensitiveness of the iris is not thereby abolished.

THE CORNEA.

Removal of a Foreign Body.—When the foreign body has penetrated to only a slight depth, it may be easily removed with the point of a knife or fine forceps; but, if it lies so near the posterior surface of the cornea that there is danger of forcing it through into the anterior chamber by the efforts made for its extraction, a lance-shaped knife must be entered very obliquely and passed behind it, between the layers of the cornea if there is sufficient space, otherwise within the anterior chamber.

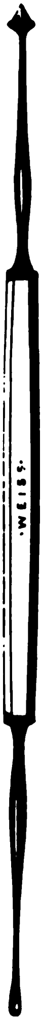
If the foreign body falls into the anterior chamber, notwithstanding these efforts to prevent it, the surgeon must wait until the aqueous humor has reaccumulated, and then make an incision three or four millimetres in length at the lower portion of the periphery of the cornea, in the hope that the foreign body will be washed out during the flow of the liquid.

Puncture of the Cornea.—This may be made with broad needle or a well-worn Beer's knife. It is advisable to employ anæsthesia, and to steady the eyeball with fixation forceps. The surgeon stands behind the patient, raises the upper lid, and fixes it against the margin of the orbit with two fingers of his left hand, which also rest against the inner side of the eyeball and prevent it from rotating inward. The needle or knife is then entered a little in front of the edge of the cornea at the outer side. Its direction must be sufficiently oblique to avoid injury to the iris, and not so much so that the instrument will remain between the layers of the cornea and fail to penetrate to the anterior chamber. By partly withdrawing the instrument and twisting it slightly, the incision is made to gape and allow the escape of the liquid; or a fine blunt probe may be passed into the incision after entire withdrawal of the needle. Subsequent tappings are effected by reopening the original wound with the probe. Figure 151 represents a combined needle and probe. The needle is provided with a shoulder to prevent its introduction to too great a depth.

Removal of a Staphyloma.—The best treatment is now thought to be enucleation of the eye, but evisceration of the globe is sometimes done.

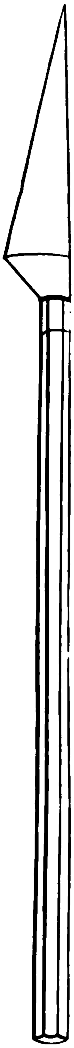
Evisceration.—The sclerotic is incised with a Beer's knife just in front of the insertion of the external rectus; into the

Fig. 151.



Stop needle and probe for puncturing the cornea.

Fig. 152.



Beer's knife.

opening is passed one blade of a pair of small blunt-pointed scissors, and the anterior portion of the globe is cut away, with the lens and all the vitreous humor. The wound is then closed with catgut sutures passed through the conjunctiva alone.

THE IRIS.

Iridotomy.—Incision of the iris may be performed for the purpose of establishing an artificial pupil. As its success depends upon the retraction of the divided fibres, it should be undertaken only when their contractility is not interfered with by too extensive adhesions, or has not been destroyed by disease. The more common lesions to which the operation is applicable are central opacity of the cornea, occlusion of the pupil, and excessive prolapse of the iris after removal of a cataract; but the danger of injury to the lens is so great that the operation is practically restricted to the class of cases last mentioned.

The best place for an artificial pupil is in the lower inner quarter of the iris, the second best in the lower outer quarter. As the portion of the cornea traversed by the knife or needle is likely to become more or less opaque in consequence, the incision in it should be made as far as possible from the point where the pupil is to be created.

Simple Incision.—Cheselden, who was the first to perform this operation, entered a narrow-bladed knife through the sclerotic just anterior to the insertion of the external rectus, the point directed toward the centre of the globe of the eye. After the point had penetrated to the depth of one-eighth of an inch it was directed forward, passed through the iris to the anterior chamber and transversely across the latter, its edge looking backward. By pressing the edge against the iris and withdrawing it a horizontal incision was made in that membrane.

Bowman punctured the cornea midway between its centre and external border, passed a narrow blunt-pointed knife through the puncture into the anterior chamber, and thence through the pupil to the posterior surface of the inner half of the iris, which he then divided by cutting forward. The danger of injury to the cornea during the last step of the operation is very great.

Bell[1] uses a double-edged needle which is "introduced through the cornea near its margin; on arriving at the place where the pupil ought to be, one edge is drawn against the iris and divides it transversely, if possible, without injuring the lens."

Vecker proposes *simple iridotomy* and *double iridotomy;* the former in cases of central opacity of the cornea or lens, the latter when the pupil has become obliterated after removal of a cataract. He uses a small lance-shaped knife with a shoulder, straight or bent upon the flat, and a pair of forceps-scissors.

Simple Iridotomy (Wecker).—The knife is entered midway between the centre and border of the cornea on the side opposite to that on which the pupil is to be made. As soon as the cornea has been perforated the knife is withdrawn and the forceps-scissors passed through the wound to the further border of the pupil, where they are opened and one of the blades passed behind, the other in front, of the iris. By closing them sharply the circular fibres are divided from the margin of the pupil toward the periphery of the iris. The scissors are then withdrawn, the iris replaced if it engages in the wound, a few drops of a solution of atropine placed between the eyelids, and a compress applied.

Double Iridotomy (Wecker).—The knife is passed perpendicularly through the cornea and iris one millimetre from the edge of the conjunctiva, on the side toward which the obliterated pupil has been retracted; its point is then made to pass along the posterior surface of the iris until arrested by its shoulder, when it is withdrawn slowly. The forceps-scissors are next introduced through the incision, and one blade passed behind and the other in front of the iris for a distance of one-quarter of an inch or a little less. Two successive sections of the iris are then made, inclosing a triangular flap, the apex of which is directed toward the incision in the cornea. The pupil is formed by the retraction of this flap.

Iridectomy.—Excision of a portion of the iris may be employed for the purpose of creating an artificial pupil

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[1] Manual of Surgical Operations, 3d edition, p. 162.

(optical iridectomy), or for the relief of tension in glaucoma or irido-choroiditis (antiphlogistic iridectomy), or as a preliminary to the removal of a cataract.[1] The size of the portion excised is determined by the length and position of the line of the incision on the posterior surface of the cornea; the nearer this is to the margin of the cornea the larger will be the portion of the iris removed. In antiphlogistic iridectomy, therefore, when the entire breadth of the iris from the pupil to its outer margin should be removed, the knife must be entered one millimetre outside of the clear portion of the cornea; in optical iridectomy, on the other hand, the excised portion should be small and the knife should be entered within the margin of the cornea. In antiphlogistic iridectomy at least one-fourth of the iris should be removed, the piece being taken from the upper segment in order that the loss may be hidden by the upper eyelid. In optical iridectomy the pupil should be made on the inner side of the lower segment unless corneal opacities are in the way.

FIG. 153.

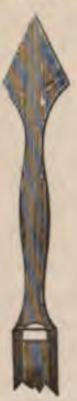
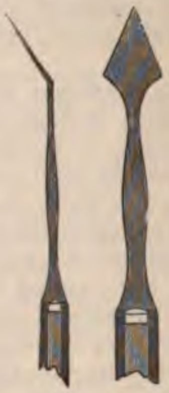


FIG. 154.



Operation for Antiphlogistic Iridectomy.—The instruments required are a lance-shaped knife, straight (Fig. 153) or bent (Fig. 154), iridectomy forceps (Figs. 155 and 156), and scissors curved upon the flat (Fig. 157).

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[1] For a complete list of the indications for iridectomy the reader is referred to Stellwag on Diseases of the Eye, p. 197. New York, Wm. Wood & Co., 1868.

FIG. 155.

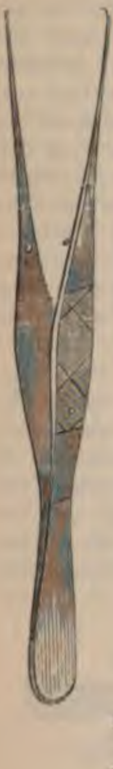


FIG. 156.

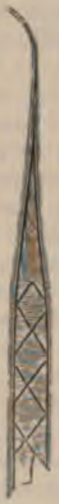


FIG. 157.

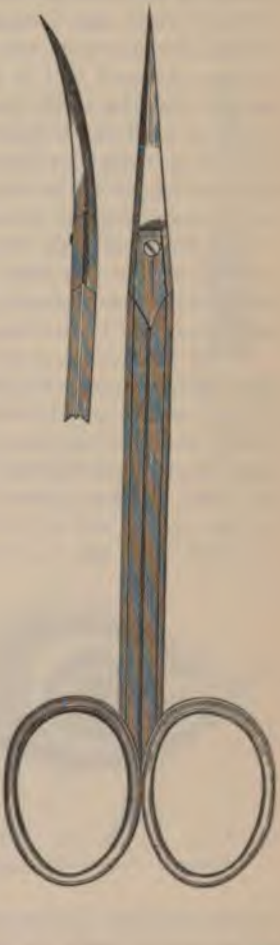
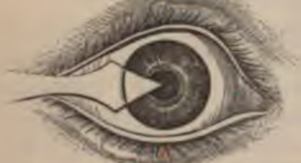


FIG. 158.



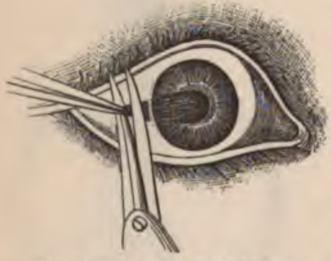
Iridectomy. Incision of cornea.

The patient having been anæsthetized and placed in a recumbent posture, the surgeon takes such a position in front of or behind him as will facilitate the making of the first incision. The eye speculum and fixation forceps having been applied, the latter immediately opposite the point of puncture, the knife is introduced perpendicularly to the surface of the sclerotic one millimetre outside of the margin of the cornea and passed steadily in until its point has entered the anterior chamber at its very rim; its direction is then changed and it is carried along the anterior surface of the iris until its point reaches the centre of the pupil, or until the length of the incision is considered sufficient (Fig. 158). By inclining the point of the knife to each side, the length of the incision in the posterior surface of the cornea may be made equal to that of the anterior surface.

The knife is then withdrawn and the aqueous humor allowed to run off very slowly in order that the relief of intra-ocular pressure may not be so sudden as to lead to congestion and hemorrhage.

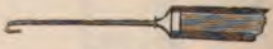
If the iris does not now present in the wound the iridectomy forceps must be introduced closed as far as to the margin of the pupil, which is then seized and drawn out gently through the incision. An assistant then cuts off with the curved scissors all the protruding portion of the iris close to the lips of the wound (Fig. 159). Or the fixation forceps may be confided to the assistant before the introduction of the iridectomy forceps, and the surgeon left free to use the scissors himself. Instead of the iridectomy forceps, Tyrrell's hook (Fig. 160) may be used to draw the iris out through the incision. It must be introduced upon its side, hooked around the margin of the pupil, and then its point must be turned toward the cornea and away from the centre of the eyeball so that it

FIG. 159.



Iridectomy. Excision of the iris.

FIG. 160.

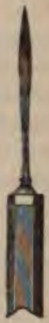


Tyrrell's hook

will not catch upon the posterior edge of the incision during its withdrawal.

If any hemorrhage takes place into the anterior chamber the escape of the blood before coagulation should be favored by separating the lips of the incision with a curette, and making gentle pressure upon the eyeball.

FIG. 161.



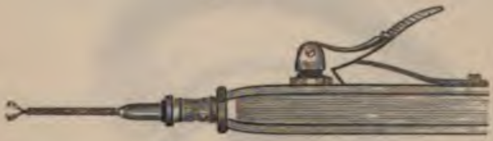
Broad needle for incising cornea.

Optical Iridectomy.—As only a small central portion of the iris is to be removed, the incision should be made in the cornea with a narrow knife or a broad needle (Fig. 161). If the margin of the pupil is adherent, the adhesions may be broken up with a blunt hook (*Corelysis, q. v.*), or a portion of the iris, not including the margin of the pupil may be pinched up and removed (*Iridorhexis, q. v.*).

Iridorhexis.—A modification of optical iridectomy introduced by Desmarres for cases in which the existence of adhesions at the margin of the pupil or the friability of the iris renders it impossible to draw out the latter through the incision in the cornea.

After the incision has been made in the cornea as for optical iridectomy, the iris is seized near the pupil with iridectomy or canula forceps (Fig. 162), drawn up into the incision, and a portion excised or torn off.

FIG. 162.



Canula forceps

Iridesis, or displacement of the pupil by ligature. Critchett, the inventor of this operation, claims[1] that by it the size, form, and direction of the pupil can be regulated to a nicety, and its mobility preserved. It is applicable to numerous groups of cases in which the natural pupil, or even a part thereof, is movable, and has a free edge; but the simplest class is that of central opacity of the cornea, in which it is only required that the natural pupil should be moved slightly to one side, so as to bring it opposite the transparent part of the cornea. It has also been used in cases of conical cornea, to change the shape of the pupil to that of a slit; and in a case where the pupil had been rendered very small and narrow by broad synechiæ, Critchett made it large and almost circular by drawing its sides apart at nearly opposite points.

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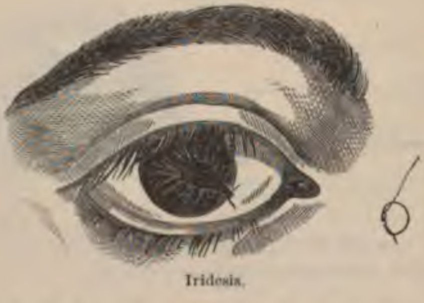
[1] Ophthalmic Hospital Reports, vol. i. p. 220.

The *operation* is performed as follows:

An opening is made with a broad needle through the margin of the cornea close to the sclerotic, and just large enough to admit the canula forceps. A small portion of the iris near but not close to its ciliary attachment is seized and drawn out to the extent considered sufficient for the proposed enlargement of the pupil; a piece of fine floss silk, previously tied in a small loop round the canula forceps, is slipped down, and carefully tightened around the portion of iris made to prolapse, so as to include and strangulate it (Fig. 163). This manœuvre is best accomplished by holding each end of the silk with a pair of small broad-bladed forceps, bringing them exactly to the spot where the knot is to be tied, and then drawing it moderately tight. The small portion of the iris included in the ligature speedily

FIG. 163.



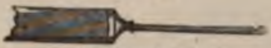
Iridesis.

shrinks, leaving the little loop of silk, which may be removed on the second day.

If it is desired to make the pupil extend to the periphery of the iris, the margin of the pupil must be seized with the forceps, and drawn out through the incision. In this case Soelberg Wells prefers a blunt hook to the canula forceps.

Corelysis, or rupture of adhesions uniting the margin of the pupil and the lens. The operation was first performed by Streatfeild, as follows:[1] He punctured the cornea with a broad needle on the outer side near its margin, passed his spatula (Fig. 164) along the anterior surface of the iris to the pupil, engaged the adhesions in the notch on the edge of the spatula, and tore them. When the entire margin of the pupil was adherent, he passed the needle along the surface of the iris, across the pupil to its opposite margin, and cut the adhesions at that point. Then withdrawing the knife, he passed the spatula through the hole thus made, and easily broke up the remaining adhesions. When the adhesions were too strong to be broken with the spatula, he used the canula scissors. A few drops of a solution of atropine should be applied to the eye, both before and after the operation.

FIG. 164.



Streatfeild's spatula hook.

OPERATIONS UNDERTAKEN FOR THE RELIEF OF CATARACT.

A cataract is an opacity of the crystalline lens, or of its capsule, or of both: the former being much the more common variety. It may be hard, soft, or semiliquid, and its condition, in this respect, has an important bearing upon the choice of a method of operation. The lens is composed of a solid nucleus and a soft cortex; the whole lying free within the capsule which is itself attached to the vitreous humor. In consequence of the absence of adhesions between the lens and the capsule, moderate pressure is sufficient to force out the former after the latter has been divided.

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[1] Ophthalmic Hospital Reports, vol. i. p. 6.

In operating upon a cataract, the patient should be recumbent; anæsthesia, though desirable, is not indispensable, except with young children or unruly patients; the other eye should be covered with a bandage, unless its sight is entirely lost; and an eye speculum may be used to keep the lids apart, if the services of a trained assistant cannot be had. The objection to a speculum is that it is somewhat in the way of the knife, cannot be removed promptly enough, and is apt to make dangerous pressure upon the eye. If used, the screw of the instrument should be loosened as soon as the incision has been made. A few drops of a solution of atropine should be placed under the lids a short time before the operation.

The methods of operation may be classified as:

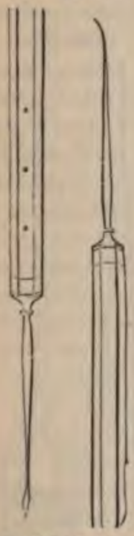
Depression or couching;
Division, discission, or solution;
Extraction;
Operation for secondary cataract.

Depression or *couching*, which was the original and, for many years, the only method of removing cataract, is now universally abandoned, on account of the danger that the displaced lens may set up inflammation of the eye by contact with the other parts, especially the iris and ciliary processes, and thus cause total loss of sight. Soelberg Wells states that about fifty per cent of the eyes thus operated upon have been lost by chronic irido-choroïditis. The operation will be described, however, for the sake of reference. If the puncture is made in the sclerotic, the operation is called *scleronyxis;* if in the cornea, *keratonyxis.*

Scleronyxis.—A curved couching needle (Fig. 165), its convexity turned upward, is passed through the sclerotic on the temporal side about four millimetres from the margin of the cornea, and three millimetres below the horizontal diameter of the eye. Its convexity is then turned forward, and the needle carried behind and parallel to the iris, across to the upper and inner margin of the pupil (Fig. 166), when the handle is lightly tilted upward, and the lens slowly depressed by the concave surface of the needle. After holding it in place for a moment, the needle is slightly rotated to disentangle its point, and withdrawn.

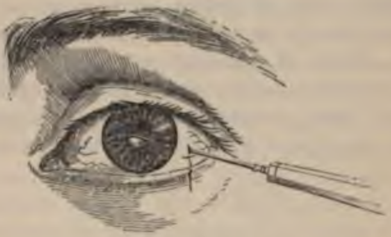
Some authors recommend that the anterior capsule should be formally divided horizontally or vertically before the lens is depressed.

FIG. 165



Conching needle.

FIG. 166.



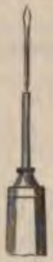
Depressing cataract.

Keratonyxis.—The needle is passed through the cornea a little below its horizontal diameter, and midway between its centre and margin, and carried backward and inward, through the pupil to the lens, which is then depressed as before.

In the variety of depression called *reclination*, the upper edge of the lens is rotated backward about its transverse axis at the same time that it is depressed, so that its anterior becomes its superior surface.

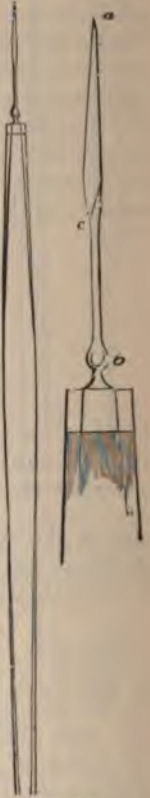
Division, *Discission*, or *Solution*.—The object of this operation is to tear open the anterior capsule with a fine needle, and by thus bringing the aqueous humor into contact with the lens to promote the gradual softening and absorption of the latter. The selection of the term discission was made in consequence of an erroneous impression, that the more completely the lens was broken up at first, the more rapidly would the work of absorption go on, and surgeons, therefore, tried to cut the whole lens into fragments. Experience has since shown that in most cases the absorption must be gradual, and the operation frequently repeated, only a small amount of the substance of the lens being allowed to come into contact with the aqueous humor on each occasion. If the lens is all broken up at once, the numerous fragments swell, and act as foreign bodies in the aqueous humor, and set up inflammation in the iris and cornea with immediate arrest of the process of absorption. This operation is more especially indicated in the cortical cataract of children, and of young persons up to the age of twenty or twenty-five years, also in those forms of lameliar cataract in which the opacity is too extensive to allow of much benefit being derived from an artificial pupil. After the age of thirty-five or forty, absorption is much slower, and the iris much more irritable.

FIG. 167.



Bowman's fine stop needle.

FIG. 168.



Hays's knife needle.

There are two methods of performing the operation; in one the needle is passed through the cornea, in the other through the sclerotic.

Division through the Cornea.—The pupil is widely dilated with atropine, the eyelids drawn apart by an assistant, or fixed with the eye speculum, and a fold of conjunctiva on the inner side of the eye seized with the fixation forceps. A fine spear-shaped needle with a shoulder (Fig. 167) is passed through the outer lower quadrant of the cornea, almost perpendicularly to its surface at a point well within the dilated pupil, so that the iris shall not be touched by the needle. One or more incisions, according to the effect desired, are then made in the anterior capsule of the lens, the needle withdrawn, and a compressive bandage applied. The operation may be repeated as soon as all redness and irritability of the eye have disappeared.

Division through the Sclerotic (Hays[1]).—The patient having been prepared as before, the knife-needle (Fig. 168), with its cutting edge upward, is passed through the sclerotic at a point on its transverse diameter three or four millimetres from the temporal margin of the cornea, and perpendicularly to the surface of the eyeball. Its direction is then changed and its point carried between the iris and lens to the opposite margin of the pupil. If it encounters and penetrates the lens on the way, it will probably dislocate it, in which case extraction should be at once performed; if the needle is pushed into the lens without dislocating it, the instrument should be withdrawn until its point is free, and then pushed on again in a better direction.

This being accomplished, the edge of the knife is turned back against the centre of the lens, and a free incision made by withdrawing it a short distance, while pressing its edge firmly against the cataract.

In order to expedite the cure, Wells thinks it is a good plan to combine division with extraction, and remove the whole cataract by a linear incision after it has been softened by contact with the aqueous humor. In children this may be done within a week after the division. The same proceeding may be employed in cases of partial cataract, the transparent portion of the lens being made opaque and softened by the introduction of the needle.

Extraction.—The methods of extraction may be classified as—

The flap;
Von Graefe's;
The linear;
The scoop;
Extraction by suction; and
Removal of the lens in its capsule.

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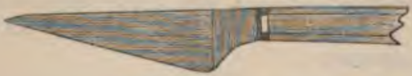
[1] American Journal of Medical Sciences, July, 1855, p. 81.

Flap Extraction.—The common flap operation is certainly the best when it is successful. It is nearly painless, does not affect the appearance of the eye, and leaves a natural movable pupil. These advantages, however, are offset by serious disadvantages; the great size of the flap involves the risk of partial or diffuse suppuration of the cornea, accompanied possibly by suppurative iritis or irido-choroiditis. Prolapse of the iris is a not unfrequent complication, and the after-treatment requires much more care and attention. Many surgeons are unwilling to use chloroform in the operation, because the wound is so large that a fit of vomiting may force out the vitreous humor, or even the retina and choroid.

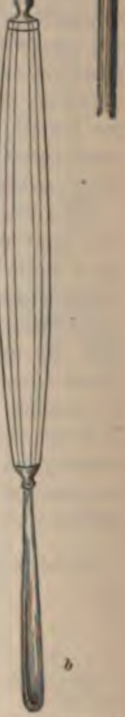
The instruments required are a Beer's (Fig. 152) or Sichel's (Fig. 169) knife, fixation forceps, Graefe's cystotome and curette (Fig. 170), and a small blunt-pointed knife or pair of scissors for enlarging the wound, if necessary.

FIG. 169.



Sichel's knife.

FIG. 170.

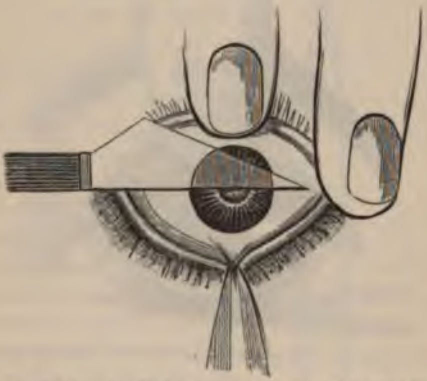


Von Graefe's cystotome and curette.

The section may be made in the upper or lower half of the cornea; the former is rather the more advantageous, the latter the easier of execution.

Operation. (Right eye, upper section.) *First Stage.*—Patient recumbent, the operator seated behind him. The eyelids are separated by an assistant standing at the patient's left side, and drawing the lids gently apart with the forefinger of each hand, without making any pressure upon the eye. The surgeon steadies the eyeball by pinching up a fold of conjunctiva, with fixation forceps, either just below the cornea, as in Fig. 171, or better, perhaps, just below its prolonged horizontal diameter on the inner side, and draws the eyeball gently down. He then enters the point of the knife at the outer side of the cornea half a millimetre within its margin, and just on its transverse diameter, and carries it steadily across the anterior chamber, taking care to keep the side of the blade parallel to the iris, and to press slightly downward with its back so that it may always fill the incision completely and prevent the escape of the aqueous humor. The counterpuncture is made, by the steady advance of the knife, at a point immediately opposite that of entry, the fixation forceps removed, and the knife pushed on in the same direction until the section is all but finished; when only a small bridge of cornea remains undivided at its upper border, the edge of the knife is inclined slightly forward, and the section completed by withdrawing the knife. Close the eyelids for a moment before beginning the second stage.

FIG. 171.

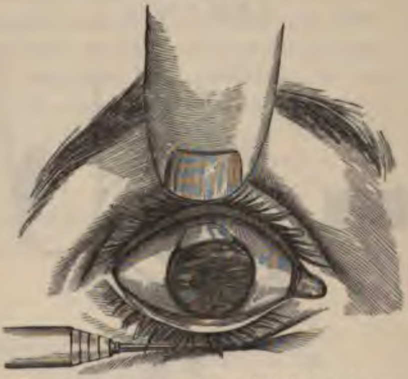


Flap extraction of cataract Mode of fixing the eye and making the incision.

Second Stage.—The anterior capsule is next divided by introducing the cystotome through the incision while the patient looks downward, and drawing its point gently across that membrane. Care must be taken not to displace the lens by pressing the point too forcibly against it. Close the eyelids again for a moment.

Third Stage.—The patient is again directed to look downward, and steady gentle pressure is made upon the eye with the forefinger or curette placed upon the lower lid (Fig. 172). This pressure should first be directed backward so as to tip the upper edge of the lens forward, and then upward and backward so as to force the lens through the dilated pupil into the anterior chamber and out through the incision. It should be gentle and very steady so as to avoid rupture of the posterior capsule and escape of the vitreous humor.

FIG. 172.



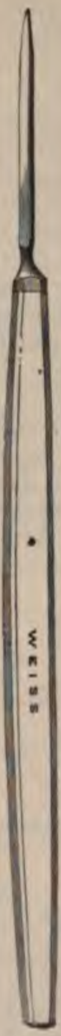
Flap extraction of cataract. Removal of the lens by pressure.

Any portions of the cortical substance of the lens which may have been left behind in the capsule, or stripped off during the passage of the lens through the pupil and the incision, must then be removed, and the eye closed.

Such was the operation employed for extraction of the ordinary, hard, senile cataract. The objections to it, as before mentioned, were the great size of the flap, the possible prolapse of the iris during the after-treatment, and the risk of iritis excited by the bruising of the iris during the passage of the lens through the pupil. Von Graefe was the first to suggest that this last risk would be diminished by the excision of a portion of the iris, iridectomy, and on putting the suggestion into practice he found that it also enabled him to remove the cataract safely through a much smaller incision. According to Mr. Carter,[1] Von Graefe worked very sedulously during several years at the endeavor to exclude, one by one, the chief sources of the dangers by which extraction was beset, and he arrived at last at the point of losing only four eyes out of one hundred operations. A few improvements in detail have been added since his death, but so far as principles and broad outlines are concerned he had covered the ground. In view of the shortness of the incision, which occupies not more than one-quarter of the periphery of the cornea, the operation is generally spoken of as a "modified linear extraction;" but the curved outline of the incision, and the fact that the lens is removed entire, certainly bring it within the class of flap extractions.

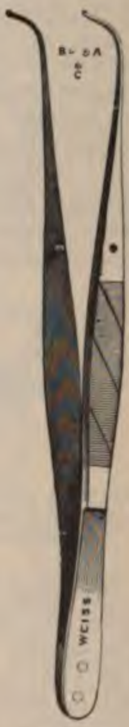
Von Graefe's Method. Modified Linear, or *Modified Flap Extraction.*—The instruments required, besides the eye speculum and fixation forceps, are a long, thin, narrow knife (Fig. 173), the blade of which is thirty millimetres long and two millimetres wide, iridectomy forceps (Fig. 174), scissors, a cystotome (Fig. 170), and a small hard-rubber or tortoise-shell curette.

FIG. 173.



Von Graefe's cataract knife.

FIG. 174.



Iridectomy forceps.

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[1] Holmes, Surgery, its Principles and Practice, p. 724.

The patient is etherized and recumbent; the surgeon stands or sits behind him, holding the knife in his right hand for the right eye, in the left hand for the left eye. The eyeball is secured with the fixation forceps, and the point of the knife is entered in the sclerotic with its edge upward, one millimetre from the upper and outer margin of the cornea, and two millimetres below a tangent to its circle drawn at the upper end of its vertical diameter (Fig. 175, *A*). The point of the knife is at first directed toward the centre of the eyeball, but as soon as it has penetrated to the anterior chamber it is turned so as to pass parallel to and along the anterior surface of the iris downward and inward about seven millimetres to a point corresponding to *B* in Fig. 175. The handle is then depressed, turning on the back of the blade in the incision, until the point is raised to the horizontal line of the puncture, when the handle must be inclined somewhat backward, and the point pushed sharply through the sclerotic and conjunctiva at *C*, Fig. 175. Great care must be taken not to make the counter-puncture too far back in the sclerotic, a mistake which may easily happen if the blade is carried too far downward and inward before it is turned up to make the counter-puncture.

FIG 175.

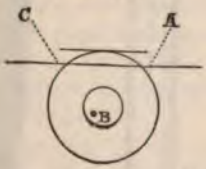
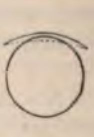


Diagram to illustrate the method of making Von Graefe's incision.

FIG. 176.



Line of Von Graefe's incision.

The edge is then directed forward, and the incision completed by steady advance and withdrawal of the knife. The incision is represented by the upper, undotted line in Fig. 176; its centre should lie at the junction of the cornea and sclerotic. The little bridge of conjunctiva which remains at the centre of the incision is then divided in such manner as to leave a conjunctival flap two or three millimetres long adherent by its base to the cornea. If the cataract is large and hard, it may be advisable to use a broader knife, and make the points of puncture and counter-puncture one millimetre lower, so that it will not be necessary to use a scoop or make much pressure on the eye to effect the removal of the lens.

Many surgeons prefer to make the incision wholly in the cornea and close to its edge, on the ground that the wound will heal more promptly and kindly, and be accompanied by less risk of loss of the vitreous or of prolapse of the iris.

The object of the *iridectomy*, which is the next step in the operation, is the neutralization of the circular fibres rather than the removal of a large portion of the iris, although some surgeons counsel the latter on account of the greater security it gives against subsequent inflammation. The iridectomy forceps are introduced closed, and opened slightly when the point reaches the margin of the pupil. The margin rises between the branches, is seized, withdrawn gently, and cut off with scissors close to the forceps. If this is properly done the angles formed by the edges of the incision and the margin of the pupil will appear in the anterior chamber as at *A* and *B* in Fig. 177. The portion of iris removed should extend quite to its ciliary insertion so that there may be none to engage in the external incision and prevent its primary union.

FIG. 177.

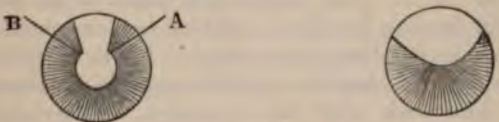


Diagram of the correct and faulty sections of the iris.

The capsule is next freely divided by two successive lacerations made with the cystotome. Each should begin at the lower edge of the pupil and extend upward, one along the inner, the other along the outer side, to the upper border of the lens, where it has been exposed by the iridectomy. This upper border should also be torn to an extent corresponding to the external incision. This manœuvre must be executed with great delicacy and lightness of touch, in order that the lens may not be displaced into the vitreous humor.

The *escape of the lens* is aided by pressure upon the cornea with the curette. The fixation forceps are applied at the inner or outer side, and the curette placed upon the lower edge of the cornea and pressed slightly backward and upward so as to cause the upper edge of the lens to present in the section; the pressure must then be made directly backward, in order that the lens may be rotated around its transverse axis and tilted well forward into the incision. The curette is then pushed slowly upward over the surface of the cornea so as to follow step by step the delivery of the lens. Any fragments scraped off during the passage may be removed by passing the curette again over the surface of the cornea.

If the vitreous humor happens to be liquid it may escape as soon as the first incision is made. In such a case it is best to excise a portion of the iris and remove the lens in its capsule by passing a scoop behind it into the vitreous humor and lifting it out.

Gayet and Knapp's Modification.—Instead of lacerating the capsule as above described these surgeons incise it with a knife-needle along the line of the corneal incision. This is followed in the great majority of cases by an unusually uneventful healing free from iritis and other complications, but leaves the pupillary area occupied by the capsule of the lens. In order to clear the pupil the capsule is subsequently (in the third week after the extraction, or later) split with the knife-needle, which permanently frees the pupil from both the anterior and posterior capsules.

Linear Extraction.—Mr. Dixon suggests[1] *rectilinear extraction* as a more suitable name, because the incision in the cornea is a straight one, in contradistinction to that of a flap extraction which also forms a line, but a curved one. This operation is a modification of one invented by Gibson in 1811, which had fallen into entire disuse before its reintroduction by Von Graefe in 1855. It is designed for the removal of soft cataracts through a small corneal incision, especially the cortical cataract of individuals between ten and thirty years of age. It is also often employed with advantage as supplementary to the needle operation. It is performed as follows:

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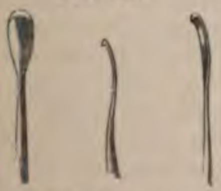
[1] Holmes's System of Surgery, vol. iii. p. 199.

A straight, vertical incision, from four to six millimetres long, is made on the outer side of the cornea, about two millimetres within its margin, with a straight lance-shaped iridectomy knife, which is passed into the anterior chamber parallel to the surface of the iris. The capsule is then freely lacerated with the cystotome, and the escape of the soft lens facilitated by the introduction of a curette into the wound, and by making gentle pressure on the inner side of the eye with the finger. If portions of the cortex remain behind the iris they can be brought into the anterior chamber by closing the lids and making gentle pressure in circular lines upon them. If the iris protrudes, it must be gently replaced, or, if much bruised, excised.

Scoop Extraction.—This is a modification of linear extraction, devised by Waldau to obviate the dangers and difficulties occasioned by the presence in the lens of a hard nucleus of greater or less size. As the principal danger ties in the bruising of the iris, Von Graefe met it by iridectomy, which afterward suggested to Waldau the idea of introducing a scoop and removing the lens without making any pressure upon the eyeball.

The instruments required are a bent lance-shaped iridectomy knife (Fig. 154), iridectomy forceps and scissors, and a thin, flat, slightly concave scoop. Waldau's scoop resembled a small spoon. Three different kinds are shown in Figs. 178, 179, 180.

FIG. 178.



Critchett's scoop.

FIG. 179.

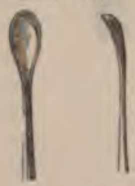
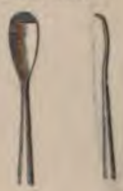


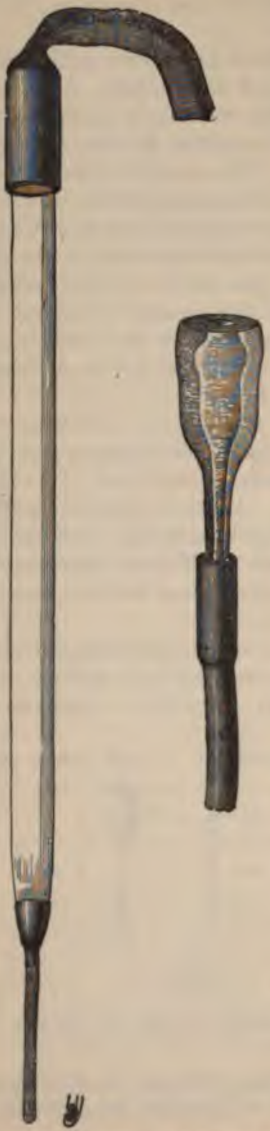
FIG. 180.



Bowman's scoops.

The eye speculum and fixation forceps having been applied, an incision, eight or nine millimetres long, is made

FIG. 181.



Curette and mouthpiece for removal of cataract by suction.

at the upper border of the cornea where it joins the sclerotic. The corresponding portion of the iris is removed, and the capsule freely torn with the cystotome, as before described.

The scoop, with its convexity backward, is then introduced, and carried carefully down behind the lens, until its extremity has passed the lower margin of the latter, and engaged it in its hook-like end. It is then withdrawn, care being taken not to press the lens against the iris and cornea. If a little of the vitreous humor escapes at the same time, it must be snipped off and a compress applied. It is better to remove any fragments of the lens that may be left behind by gently rubbing the eyeball, rather than reintroducing the scoop.

Removal by Suction.—Laugier suggested, in 1847, the removal of soft cataracts by aspiration through a hollow needle. Blanchet modified the method by substituting a small canula for the needle, and introducing it through an incision in the cornea, but the operation was not favorably received until after it had been again modified by T. Pridgin Teale, Jr., in 1863, who recommended it as a substitute for pressure in the removal of the harder portions of the cataract by linear extraction, and as supplementary to discission. The instruments required are a broad needle and a suction curette. The latter (Fig. 181) is described by Mr. Teale[1] as consisting of three parts, a curette, handle, and suction tube. "The curette is of the size of the ordinary curette, but differs from it in being roofed in to within one line of its extremity, thus forming a tube flattened on its upper surface, and terminating, as it were, in a small cup."

The anterior capsule is first ruptured with a fine needle passed through the cornea, and then an opening is made with a broad needle in the cornea through which the curette is passed to the centre of the pupil. The soft matter is then withdrawn by suction.

Soelberg Wells[2] says this operation has been employed at the Royal London Ophthalmic Hospital with great success, and that it is especially indicated in cases of soft cortical cataract. If the cataract is somewhat harder, it is well to break it up with the needle a few days before attempting to remove it.

Removal of the Lens in its Capsule.—This operation is indicated when the capsule is opaque, and whenever the eye is exceptionally irritable, or has been chronically inflamed, so that the accidental retention of any fragments of the lens would be a source of serious danger. When successful, this method gives very fine results, but its risks and dangers are so great that it is seldom employed. Originally introduced by Richter and Beer, it was revived by Sperino, Pagenstecher, and Wecker. The former employed the ordinary flap operation without laceration of the capsule. Pagenstecher made a large flap in the sclerotic together with iridectomy. Wecker's method was nearly identical, the incision being made at the sclero-corneal junction.

Pagenstecher's Method.—The patient having been thoroughly anæsthetized, a large flap is made, usually downward, with a Beer's knife, a small bridge of conjunctiva being left temporarily at its apex. Iridectomy is then performed in the outer lower quadrant, and the conjunctival bridge divided with blunt-pointed scissors. Any posterior synechiæ that may exist are torn through with a fine silver hook, and then the lens removed in its capsule by slight pressure upon the eyeball. If the hyaloid membrane should be ruptured and the vitreous escape, the lens must be removed with the aid of a small scoop passed in behind its lower edge.

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[1] Ophthalmic Hospital Reports, vol iv, part 2, p. 197.

[2] On the Diseases of the Eye, p. 280. Phila., H. C. Lea.

Secondary Cataract.—Secondary cataracts vary much in thickness and opacity. They may be produced by portions of the lens left behind and becoming entangled in the capsule, by the deposit of lymph upon the latter, or by the proliferation of the intracapsular cells. No operation for secondary cataract should be performed, until, at least, three or four months after the removal of the primary cataract; and if the pupil has become contracted, or if very extensive posterior synechiæ have formed, a preliminary iridectomy should be made. Formerly the plan was to remove the opaque and thickened membrane entirely from the eye, but it has proved very much safer and equally efficacious to make a small opening in the membrane with a needle.

Anæsthesia is hardly necessary. The eye speculum and fixation forceps having been applied, Bowman's fine needle (Fig. 167) is passed through the cornea near its margin, and an effort made to tear a hole with it in the centre of the membrane or at the part which is thinnest and least opaque.

If the membrane yields before the needle, or if it is too tough to be torn, Mr. Bowman's device of a second needle must be employed. This is to be passed through the cornea on the side opposite to that occupied by the first needle, and then the operator, transfixing and steadying the membrane with one needle, tears it with the other. If any portion of the iris should happen to be bruised or torn, it must be excised through a linear excision.

Dr. Agnew passes a needle through the centre of the membrane, thus steadying both it and the eye. He then makes a linear incision on the temporal side of the cornea through which he passes a small sharp-pointed hook, the point of which is passed into the same opening in the membrane as the needle. He next tears the membrane, rolls it up about the hook, and either draws it out altogether or, if this cannot be done, tears it widely open.

OPERATION TO CORRECT STRABISMUS—STRABOTOMY.

The tendon of the internal rectus is attached to the sclerotic at a distance of five millimetres from the border of the cornea, that of the external rectus at a distance of seven millimetres. Each tendon is seven or eight millimetres broad and is contained in a firm sheath resembling a glove finger, a prolongation or depression of the capsule of Tenon at the point where it is traversed by the tendon about midway between the anterior margin of the orbit and the posterior pole of the eyeball. The capsule of Tenon is a reflection of the periosteum of the orbit from the anterior margin of the latter to the transverse meridian of the eyeball and thence backward to and along the optic nerve, thus constituting a diaphragm which divides the orbit into an anterior and a posterior loge, the former of which contains the eyeball (received into a cup-like depression of the diaphragm), the latter the muscles and optic nerve. The capsule sends a prolongation, not only anteriorly along the tendons, but also posteriorly along the muscles, and the union between the muscle and sheath is so firm that even after division of the tendon the muscle can move the eyeball by acting through the attachments of the capsule. If the body of the muscle itself is divided in the posterior loge, its influence upon the movements of the eyeball is entirely lost. This is the chief point to be borne in mind in performing strabotomy, the tendon must be divided, not the muscle, and the amount of deviation of the eye to be overcome is the measure of the extent to which the adjoining tissues must be divided.

The Operation for Division of the Internal Rectus will alone be described, that being the one commonly required. The special instruments required are: fine-toothed forceps (Fig. 182), blunt hook (Fig. 183), and blunt-pointed scissors, straight or curved on the flat.

A small but deep fold of conjunctiva and subconjunctival tissue is seized with the toothed forceps just above the lower extremity of the line of insertion of the tendon of the internal rectus, that is two millimetres below a point on the equator of the eyeball five millimetres beyond the inner margin of the cornea, and divided with the scissors just below the forceps; additional snips are made with the scissors within this opening until the tendon or the sclerotic is exposed. The surgeon then passes the point of the strabotomy hook, which should be somewhat bulbous, through the opening to the lower border of the tendon, and, keeping the point and side of the hook constantly upon the sclerotic, sweeps it at first backward, and then upward and forward

FIG. 182.

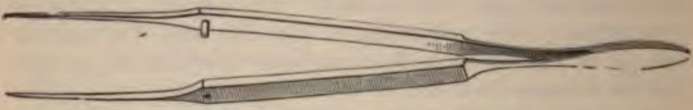
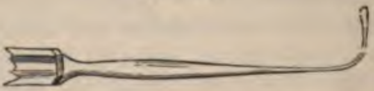


FIG. 183.



around the insertion. When this manœuvre is properly executed, the point of the hook can be seen under the conjunctiva above the upper border of the tendon, while its course is hidden by the latter and prevented from being drawn forward to the margin of the cornea. If the whole of the hook can be seen under the conjunctiva, it is not under the tendon, and the sweep must be repeated. When the tendon has been secured, the conjunctiva may be pressed back over its point, and the tendon divided with scissors close to its insertion, beginning at its upper border; or, the conjunctiva being left in place, the scissors may be passed along the hook as a guide, one blade below the tendon, the other between it and the conjunctiva, and the tendon divided with repeated snips.

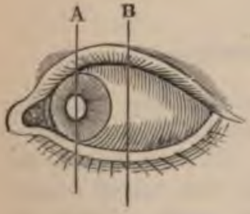
After the tendon has been completely cut through, the hook should be swept upward and downward to ascertain if the lateral expansions of the tendon have been divided, for the persistence of even a few of them might be sufficient to prevent the success of the operation.

If it is feared that too great an effect has been produced, a deep suture may be passed through the tendon and the conjunctiva on the side toward the cornea so as to limit the amount of retraction. The accommodative movements of the eye should be tested immediately after the operation, and if there is the slightest tendency to divergence when the object is six or eight inches distant from the eye a suture should be inserted.

In the *subconjunctival method* the incision in the conjunctiva is made below the insertion of the tendon on a line with the lower border of the cornea, and the conjunctiva is not pressed away from the anterior surface of the tendon after the hook has been passed under the latter.

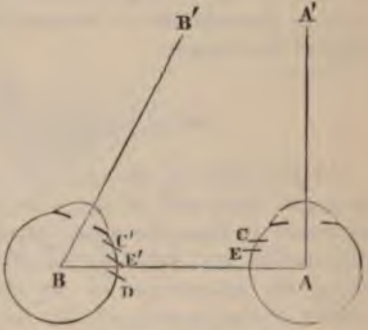
If the squint exceeds five or six millimetres, as estimated by the method shown in Fig. 184, both eyes should be operated upon, the insertion of the internal rectus being set back in each case. Thus, if the degree of squint represented in Fig. 185 were corrected by setting back the tendon of the internal rectus from *C′* to *D*, the muscle could only work at a great disadvantage as compared with the internal rectus of the other side, and the result would be the appearance of divergent squint whenever the attempt

FIG. 184.



Method of estimating the degree of squint.

FIG. 185.



Double operation for strabismus.

was made to look at an object near the eye, because the muscle could not turn the eye far enough inward. The condition must therefore be divided between the two eyes, the internal rectus on one side being set back to E, on the other side to E'.

Secondary Strabismus following Tenotomy of the opponent is treated by advancing the insertion of the tendon of the latter (*Prorraphy*). Thus, supposing divergent squint to have followed division of the internal rectus, an incision half an inch long is made in the conjunctiva in the line of the horizontal diameter of the cornea, and the conjunctiva and subconjunctival tissue dissected up as far back as to the caruncle. A hook is then passed around the insertion of the internal rectus, and the tendon divided as before; a suture is passed through it, and it is drawn toward, and fastened to, the strip of conjunctiva adjoining the inner border of the cornea. The tendon of the external rectus must then be divided according to the rules laid down for division of the internal rectus, remembering that its attachment to the sclerotic is distant seven millimetres from the edge of the cornea.

ENUCLEATION OF THE EYEBALL.

As the globe of the eye lies somewhat nearer the inner than the outer side of the orbit, it will be found easier to approach it from the latter quarter. Tillaux[1] divides the conjunctiva and subconjunctival fascia with curved scissors along the attachment of the external rectus, divides the tendon of that muscle, carries the scissors backward through the incision, their concavity turned toward the globe, and cuts the optic nerve close to the eyeball. He then seizes the posterior pole of the globe with pronged forceps, draws it out through the conjunctival incision, and divides the remaining conjunctival attachments and tendons close to the sclerotic.

Other surgeons prefer to seek and divide each tendon in turn before cutting the optic nerve.

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[1] Anatomie Topographique, p. 190.

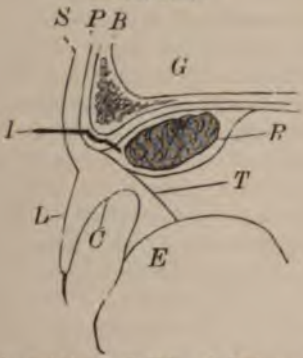
Extirpation of the Entire Contents of the Orbit.—In order to gain additional room, it is well first to divide the external commissure of the lids. A bistoury is then entered at the inner angle, carried well back toward the apex of the orbit, and swept along the floor to the outer angle, then reintroduced at the inner angle, and carried along the roof of the orbit to the outer angle. The muscles and optic nerve, which still remain attached to the eye and apex of the orbit, are finally divided with curved scissors introduced from the outer side.

Hemorrhage should be arrested by packing the cavity with antiseptic gauze.

OPERATIONS UPON THE LACHRYMAL APPARATUS.

Extirpation of the Lachrymal Gland (Fig. 186).—The principal portion of the lachrymal gland lies just behind the

FIG. 186.



Extirpation of the lachrymal gland. *S.* Skin. *P.* Periosteum. *B.* Frontal bone. *G.* Lachrymal gland. *T.* Capsule of Tenon. *R.* Reflected periosteum forming the capsule of the gland. *E.* Eyeball. *C.* Conjunctiva. *L.* Eyelid. *I.* Incision.

junction of the upper and outer margins of the orbit, enveloped in a fibrous capsule formed by a reflection of the periosteum or capsule of Tenon. The "accessory" portion, together with the ducts, occupies the adjoining eyelid, and is composed of isolated granulations of glandular tissue, which, if left behind after removal of the main portion, may continue to secrete tears and discharge them into the wound, thus causing abscesses and fistulæ.

Tillaux[1] has pointed out that the existence of the fibrous capsule renders it possible to enucleate the gland without opening the posterior loge of the orbit, a defect in the older methods which included division of the external commissure. Make an incision one inch in length along the upper and outer portion of the bony margin of the orbit. Carry this incision through all the soft parts, including the periosteum, down to the bone; separate the periosteum from the bone at the under side of the incision, and depress it. The gland can then be distinctly seen through the thin layer of periosteum which separates it from the roof of the orbit, and can be removed with great ease after the latter has been torn through.

Lachrymal Sac, Duct, and Canaliculi.—The lower canaliculus passes downward from the punctum for two millimetres, then turns at a right angle, and passes horizontally inward to the lachrymal sac, a distance of about five millimetres; the upper canaliculus passes at first upward for two millimetres, and then downward and inward to the sac. This sharp turn in the course of the canaliculus, which is an obstacle to catheterization, can be temporarily removed by drawing the border of the lid outward. The lachrymal sac lies just behind the tendo oculi, and receives the canaliculi by a common duct two or three millimetres below its upper extremity, their relations thus resembling those of the ilium and cæcum, a resemblance which is increased by the presence of a valve at the opening of the duct into the sac. This valve, described by Huschka, is thought to prevent the reflux of the contents of the sac into the canaliculi. The direction of the sac is downward and backward at an angle of 45°; it occupies the lachrymal groove, which is bounded anteriorly by a ridge on the nasal process of the superior maxillary bone at the inner angle of the orbit, and is crossed by the tendo oculi just at the junction of its upper and middle thirds. The nasal duct is the direct continuation of the sac, and passes downward, backward, and outward; the combined length of the duct and sac is about one inch.

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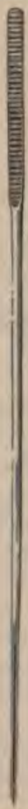
[1] Anatomie Topographique, p. 237.

It may become necessary to *slit up the canaliculus* in order to correct a malposition of the punctum, or to facilitate catheterization of the sac and nasal duct. This little operation is best performed as follows (right eye, lower lid): The surgeon stands behind the patient, who is recumbent, and introduces a fine grooved director (Fig. 187) vertically through the punctum for a distance of two millimetres. Then drawing the border of the lid outward and somewhat downward with the forefinger of his left hand, he passes the director horizontally, with its groove upward, along the canaliculus to the inner side of the sac. Then, shifting the director to the left hand, he engages a sharp-pointed knife in the groove, and slits up the canaliculus throughout its entire length.

Bowman's probe-pointed canaliculus knife (Fig. 188) may be substituted for the director and knife. It should be very narrow, and its probe point very small.

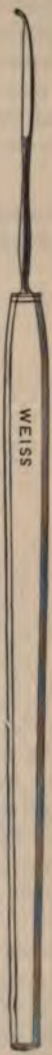
When one punctum has been entirely obliterated, a plan suggested by Mr. Streatfeild may be employed. He divides the other canaliculus, passes a fine director, suitably bent, through

[Fig. 187.



Sharp pointed canaliculus director.

Fig. 188.



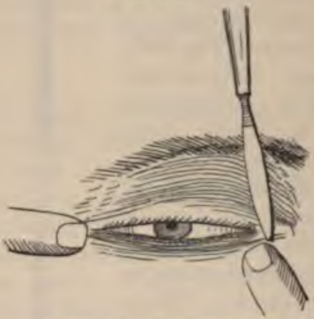
Bowman's probe-pointed canaliculus knife.

the wound into the obliterated canaliculus and cuts down upon it.

If the divided lower canaliculus remains everted, Mr. Critchett advises that the posterior lip of the incision be cut off with scissors, "effecting the treble object of drawing the canal further inward, of forming a reservoir into which the tears may run, and of preventing reunion of the parts."

Puncture of the Sac (Fig. 189).—The three guides are the tendo oculi, the anterior margin of the lachrymal groove, and the direction of the sac. While an assistant draws the external commissure outward, so as to make the tendo oculi tense and plainly visible, the surgeon places his left forefinger upon the inner and lower margin of the orbit, so as to have the bony edge between the nail and the pulp of the finger, and holding the knife in the direction of the canal, that is, nearly parallel to the median plane, and at an angle of 45° with the horizon, he passes it along his finger-nail into the sac just below the tendon. It is important to mark the position of the anterior margin of the canal, so as to avoid the not infrequent mistake of passing the knife entirely outside of the orbit between the soft parts of the face and the bone.

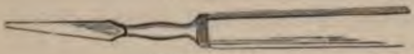
FIG. 189.



Puncture of the lachrymal sac.

Stricture of the Nasal Duct. Division.—Dr. Stilling, of Cassel, proposes to treat stricture of the nasal duct by internal division. He divides the canaliculus, and ascertains the seat of the stricture with a probe, passes his knife (Fig. 190) through it, and divides it in three or four directions.

Fig. 190.



Stilling's knife.

CHAPTER II.

OPERATIONS UPON THE EAR AND ITS APPENDAGES.

OCCLUSION OF EXTERNAL AUDITORY CANAL.

Congenital occlusion of the external meatus is usually associated with absence or defective development of the other portions of the auditory apparatus. Before operating upon such an occlusion, therefore, the hearing power should be tested, and the permeability or impermeability of the bony portion of the canal determined by puncture with a needle.

If the occlusion consists of a simple membranous diaphragm it should be divided crucially, and the flaps excised. For deeper and more extensive obstructions cauterization with nitrate of silver is to be preferred.

INTRODUCTION OF SPECULUM (ROOSA).

The upper portion of the auricle is grasped between the ring and middle fingers of the left hand and drawn gently upward and backward. Into the canal thus straightened the speculum is introduced with the right hand, and then held in place with the thumb and forefinger of the left, the hand being steadied by resting its ulnar border against the patient's head. Complete control of the speculum is thus obtained, and it can be easily moved about so as to bring every part of the tympanum and canal into view. Light should be thrown into it from a concave mirror perforated in the centre and having a focal distance of six inches.

PARACENTESIS OF THE MEMBRANA TYMPANI (ROOSA).[1]

This should be performed while the head of the patient is well supported and a good light is thrown upon the membrane by a mirror attached to a forehead band. A cataract needle is the instrument usually employed, and the opening should be made in the posterior inferior quadrant of the membrane.

Tillaux[2] calls attention to the fact that all the important elements of the membrane occupy its upper half, and that an incision or rupture near the handle of the hammer may give rise to troublesome and even dangerous hemorrhage. The lower half is less vascular and less sensitive.

If it is desired to maintain the opening for several days, a crucial incision may be made, or a triangular flap excised, but, as a rule, even these incisions heal very quickly.

INCISION OF THE PERIOSTEUM AND OPENING OF THE MASTOID PROCESS.

When the periosteum of the mastoid process has become inflamed by propagation of an inflammatory process either from the periosteum of the auditory canal with which it is continuous, or from the cavity of the tympanum through the mastoid cells, an early and free incision down to the bone will give great relief and diminish the danger of intracranial complications. The incision should begin a little above the apex of the mastoid process, and be carried upward for an inch or an inch and a half parallel to the attachment of the ear and about half an inch from it. The posterior auricular artery lies in the groove between the ear and the mastoid process, and will not be encountered; its posterior branch, however, the course of which is uncertain, will probably be divided and may give rise to troublesome hemorrhage. The artery is so adherent to the skin that it cannot be readily tied or twisted. If ordinary pressure does not suffice, self-retaining forceps should be applied to the bleeding point, and left in place for twenty-four hours.

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[1] Treatise on the Diseases of the Ear, p. 246.

[2] Anatomie Topographique, p. 111.

The chisel, which should be only one-eighth inch wide, should be applied close behind the insertion of the auricle on a level with the upper wall of the meatus, at a shallow depression, known as Desarenne's pit, and the cutting should be done inward and forward, parallel to the meatus. The proximity of the lateral sinus must be borne in mind.

CATHETERIZATION OF THE EUSTACHIAN TUBE.

The Eustachian tube is from one and a half to two inches long, its course is from the pharynx upward, backward, and outward. Its pharyngeal orifice is oval and well marked except on the lower border, and is situated just above the base of the soft palate. Behind the orifice, between it and the posterior wall of the pharynx, is a depression (Rosenmüller's fossette) in which the beak of the catheter, if carried too far back, may lodge and give the same sensation to the surgeon's hand as if it were engaged in the tube. Of the two mistakes most frequently made in performing catheterization, one is to pass the beak of the instrument between the middle and inferior turbinated bones instead of along the floor of the nasal fossa, and the other is to mistake Rosenmüller's fossette for the orifice. According to Roosa,[1] the first mistake is best avoided by drawing down the patient's upper lip with the left hand, and entering the catheter while it is held in an almost vertical position, its concavity directed toward the median line. After the beak has fairly entered the meatus the stem of the catheter is gradually raised to the horizontal position and passed backward, its beak resting on the floor of the meatus close to the septum, its convexity upward.

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[1] Diseases of the Ear, p. 94.

Tillaux[1] gives the following directions for finding the orifice: 1st. Carry the catheter directly backward, its concavity downward, until it touches the posterior wall of the pharynx. 2d. Withdraw it until the beak rests again upon the hard palate. 3d. Carry the catheter again very gently backward, and feel with its beak for the posterior border of the palatine aponeurosis, the firm fibrous continuation of the palatal bone. This aponeurosis feels as hard as bone, and its posterior border can be easily recognized by the softness of the adjoining tissues. 4th. Rotate the beak of the catheter outward and upward, and it will enter the Eustachian tube.

CHAPTER III.

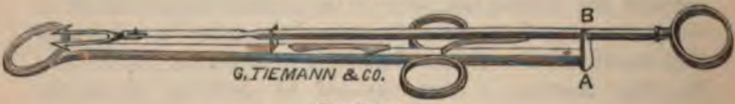
OPERATIONS UPON THE MOUTH AND PHARYNX.

EXCISION OF THE TONSILS (AMYGDALOTOMY).

THE tonsils may be excised with a knife and vulsellum, or with a specially contrived instrument, the tonsilotome or guillotine.

Anæsthesia is not required. If the patient is young or nervous it is well to put a large piece of cork between the jaws on each side to prevent the mouth from being closed. The tonsilotome (Fig. 191) is composed of two rings and a fork mounted upon stems so arranged that they can be worked with the thumb and fingers of one hand. The two rings slide flatwise upon each other, and the inner edge of

FIG. 191.



Tonsilotome.

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[1] Anatomie Topographique, p. 140.

one is sharp, so that when drawn across the other it divides anything lying within it. The fork is thrust forward across the ring and drawn away vertically from it by the same movement which draws one ring across the other. The rings having been placed over the tonsil, the hook is driven into the latter by a quick movement of the thumb and finger and draws it further into the ring, holding it tense as the other blade cuts across its base. The pain is very slight.

If the tonsilotome cannot be used the tonsil must be seized with pronged forceps, and excised between them and the pillars with a probe-pointed knife, the posterior portion of the blade being guarded with diachylon plaster so as to avoid injury to the tongue.

STAPHYLORAPHY.

At the conclusion of his historical account of this operation Verneuil[1] states that it has been invented four different times. The earliest record of the operation is found in a French book published in 1766,[2] in which it is said that a dentist, named Lemonnier, closed a fissure of both hard and soft palates by freshening its edges with a knife and bringing them together with sutures. He also closed perforations of the hard palate by exciting suppuration of their borders.

In 1799 Eustache, a physician of Beziers, proposed to reunite by sutures the edges of an incision which he had made the day before in the soft palate of a patient for the purpose of removing a pharyngeal polyp. The patient refused the operation. Four years later, in 1803, Eustache sent to the Académie Royale de Chirurgie at Paris a remarkable paper upon congenital fissures in the soft palate, and asked the Society's approval of the operation by which he proposed to close them. The approval was withheld, and there is no record of any further steps having been taken.

In December, 1816, Von Graefe said, before the Medico-Chirurgical Society of Berlin, that, after many unsuccessful attempts to close fissures of the soft palate, he had at last succeeded by drawing the edges together with sutures after freshening them by applying muriatic acid and the tincture of cantharides. This remark was reported in the proceedings of the Society in *Hufeland's Journal*, January, 1817. Between 1816 and 1820 Von Graefe repeated the operation three times, each time without success.

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[1] Chirurgie Réparatrice, 1877. Art. Staphylorrhaphie.
[2] Traité des Principaux objets de Médecine, par Robert.

In 1819, Roux, apparently in entire ignorance of Von Graefe's attempt, closed a fissure by paring the edges and applying sutures. The case at once became very widely known, and had much influence in popularizing the operation.

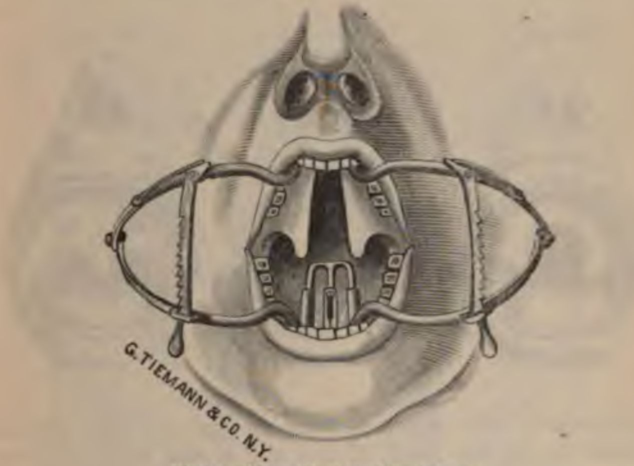
When the extent of the lesion which staphyloraphy is designed to repair is considered, the operation seems to be very simple. It is only necessary to freshen the edges of the gap and draw them together with sutures. Practically, however, the operation is a difficult one; the parts lie at a considerable distance from the surface, the manipulations are constantly interfered with by involuntary movements of deglutition, the flow of blood increases the obscurity, and the practical difficulties in the way of placing the sutures are great. Finally, unless some of the muscles of the palate are divided, the tension exerted by them upon the sutures is sufficient to prevent union.

A great variety of methods have been suggested to overcome these difficulties. Mr. T. Smith diminished the first by the invention of a gag (Fig. 192), designed to hold the jaws apart during the operation. Prof. Van Buren prevented the passage of blood into the trachea during the employment of anæsthesia by placing the patient so that the head should hang down over the end of the table, and the blood escape through the nose. The same device has been recently employed by Trélat.

Sir William Fergusson relieved the tension by dividing the levator palati on each side. He did this by passing a knife, bent at a right angle, through the cleft and dividing the muscle from behind forward, without touching the mucous membrane on the anterior face of the palate. The incision should be perpendicular to the centre of a line joining the hamular process and the orifice of the Eustachian tube. The former can be readily felt just behind the last upper molar tooth, the latter can usually be seen through the cleft in the palate. He also recommended division of the palato-pharyngeus muscle.

Sédillot[1] divided the muscle from before backward. He drew the velum downward and inward with pronged forceps, and made an incision downward and outward about one centimetre above and on the outer side of the base of the uvula, and just behind and on the inner side of the last upper molar, crossing the levator palati at right angles (Fig. 194). A length of one centimetre is usually sufficient, but it must be increased if the muscular contractions persist. The relaxation of the parts produced by these incisions is shown by a comparison of Figs. 193 and 195. Unless the incisions are exceptionally large their sides remain in contact; in any case they promptly reunite. He then divided the anterior and posterior pillars, seizing each in turn near its centre with pronged forceps, and cutting it with scissors.

FIG. 192.



Whitehead's modification of Smith's gag.

Mr. George Pollock[2] has modified this slightly by making the incision on the anterior surface of the palate smaller. One of the halves of the palate is drawn toward the median line by means of a ligature passed through it near the base of the uvula, and a thin, narrow knife is entered close to the hamular process, a little in front of it and on its inner side, and its point carried upward, backward, and somewhat inward, until it can be seen through the cleft, having divided on its way part, if not all, of the tendon of the tensor palati. The blade now lies above most of the fibres of the levator (Fig. 196), and by raising the handle and cutting downward, as the knife is withdrawn, an incision of considerable length, including the greater portion of the levator, is made on the posterior surface of the palate, while that on the anterior surface need not be greater than the breadth of the knife. If the muscle has been effectually divided the palate will be pendulous and flaccid, and will not contract spasmodically when pulled upon. If any resistance should persist the knife must be introduced again through the wound and the incision enlarged downward.

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[1] Médecine Opératoire, vol. ii. p. 65.
[2] Holmes's System of Surgery, vol. iv. p. 426.

FIG. 193.

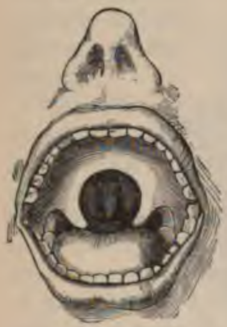


FIG. 194.

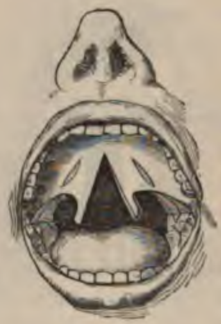
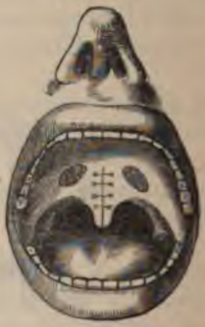
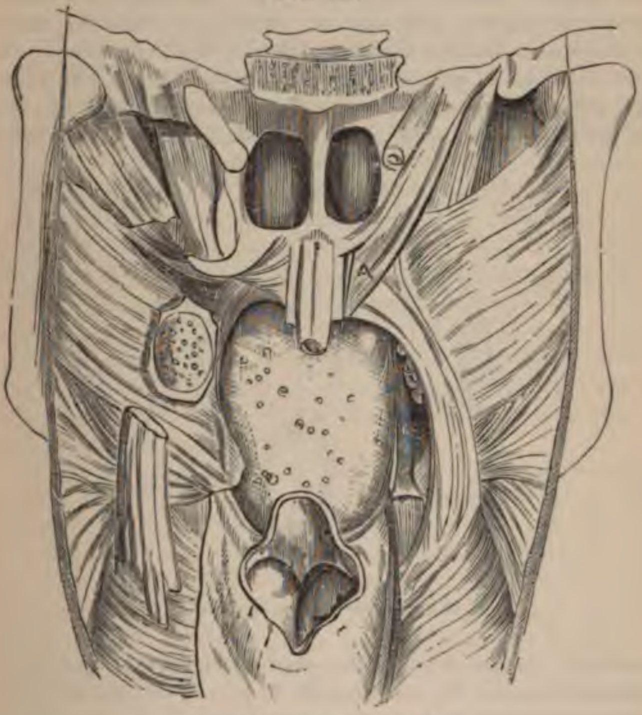


FIG. 195.



Roux placed his sutures by putting a needle at each end of the thread, and passing them from behind forward. Trélat used a needle fixed upon a long handle, the point bearing the eye and curved in the form of a U. After having been threaded the point of the needle was passed through the palate from behind forward, the thread was drawn through with a hook or forceps, and the needle, still threaded, withdrawn and passed in the same manner on the opposite side. The objection to these and to all other methods in which the needle is passed from behind forward, is that, since the point cannot be seen, it is very difficult to make the punctures on one side correspond properly with those on the other. If silk sutures are used each end may be passed from before backward, the two tied together loosely, and the knot pulled back through one of the punctures, thus bringing the loop behind the palate.

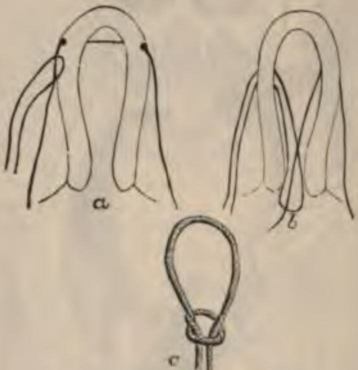
Fig. 196.



Division of muscles of soft palate.

The method now usually employed is the one introduced by Bérard. A curved needle fixed on a long handle is threaded with a ligature three feet long, and its point passed through the palate from before backward; the thread is caught with hook or forceps on the posterior side, and its end drawn out through the mouth, the needle is then withdrawn and slipped off the thread. It is next threaded with a second ligature and passed in the same manner through the opposite half of the palate, the loop seized as before, drawn through a short distance, and held while the needle is withdrawn, leaving the thread double in the puncture—the loop behind the palate, the two ends in front. The posterior end of the first ligature is then passed through the loop of the second one (Fig. 197, *b*), and, by the withdrawal of the latter, drawn through the second puncture (Fig. 197, *a*). Instead of using the same needle to pass both ligatures, it is more convenient to have two curved spirally in the opposite directions, one for each side.

FIG. 197.



Staphyloraphy; passing the sutures.

If silver sutures are used, thread loops should be passed from before backward on each side, one end of the wire engaged in each and drawn through.

After a suture has been passed, the ends should be brought out through the mouth, and tied together for safety. When all have been passed, the anterior one is drawn upon to bring the edges of the cleft together, and the knot tied. The knot may be an ordinary square one, an assistant holding the first twist with dressing forceps until the second is made, or it may be a noose, as shown in Fig. 197, *c*, secured by a second knot. If silver wire is used, it may be fastened by twisting it, or by clamping a small lead button upon it. Verneuil first passes the ends of the wire through the eyes of a shirt button, and then ties or twists. He thinks this favors more accurate adjustment of the edges, and facilitates removal of the wire.

The edges of the cleft are pared by seizing the tip of the uvula with toothed forceps, making it tense, entering the point of a narrow-bladed knife one or two millimetres back from the edge, and cutting down to the tip; then turning the knife and cutting up to the anterior angle of the cleft. Care should be taken to do this thoroughly. When the cleft is very short (bifid uvula), Nélaton employed the method already described under his name for single uncomplicated harelip. The flaps were left adherent to each other at the apex (angle of the cleft) and to the uvula at their bases, turned down, and the raw surfaces drawn together. When the cleft was too long for this he separated the flaps at the apex, shortened them by trimming off the free ends, turned them down, and united as before.

There is no settled rule of practice establishing the order in which the different steps of the operation shall be executed, except that most surgeons are agreed upon the advisability of paring the edges of the cleft before passing the sutures. Mr. Callender recommended that the muscles should be divided a day or two before the attempt to close the cleft, on the ground that the second operation is much simplified by the freedom from the bleeding occasioned by division of the muscles. Mr. Smith, on the other hand, stretched the palate by drawing upon all the sutures, divided the palato-pharyngeus and levator palati, and then, if the edges of the cleft did not come easily together, made two lateral oblique cuts, one on either side, above the higher suture, separating, to a limited extent, the soft from the margin of the hard palate.

Bonfils, according to Dubrueil, closed an opening left at the upper part of the palate by the partial failure of an operation for staphyloraphy, by taking a flap from the hard palate, according to the Indian method of autoplasty (*q. v.*).

URANOPLASTY.

Verneuil[1] attributes the success of modern uranoplastic operations to the use of the method by double flaps, adherent at both ends and brought together laterally (*lambeaux en pont*), and to the retention of the periosteum in the flaps. He ascribes the first use of double flaps to Dieffenbach, and thinks the retention of the periosteum was brought about by Ollier's most valuable experimental and clinical researches upon the properties of this tissue. To Von Langenbeck, by whose name the method is usually known, he gives only the credit of being the first to adopt Ollier's suggestion, and to make it a rule of practice.

This estimate of the facts does not seem to be entirely correct. It is true that Dieffenbach used double lateral flaps, but a large part of the success of the modern method is due to the greater breadth now given to the flaps. Tillaux has shown that the branches of the posterior palatine artery are given off like the plumes of a feather, and that to avoid division of these branches, and insure the nutrition of the flap, the incision must be made close to the alveolar process. This necessity is as absolute in the case of a small perforation as in that of a large one. As for the retention of the periosteum, Von Langenbeck was certainly the first to point out its importance as a means of preventing gangrene of the flap. Ollier's investigations turned upon its value in favoring reproduction of the bone.

Fissure of the hard and soft palate endangers an infant's life by interfering with the ingestion of food. The exact measure of this danger has not yet been established by statistics, but it is certainly considerable.[2] On the other hand, all recorded operations for cleft palate upon children less than one month old have terminated fatally, and those undertaken during the first five or six months of the child's life, although not so fatal, show but few successes. Billroth and Simon think the operation should be performed about the eighth month, but most surgeons are agreed upon the propriety of postponing it until the third or fourth year. If a child has lived six months without operation, it has certainly learned to overcome the mechanical difficulties in the way of its nourishment, and there is, consequently, no reason to interfere surgically until the second indication arises. That is found in the defective articulation and phonation occasioned by the lesion, and, as children with cleft palate do not begin to speak before the third or fourth year, the operation may be safely postponed until that time.

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[1] Chirurgie Réparatrice, Art. *Uranoplastie.*

[2] Lannelongue, Mém. de la Soc. de Chirurgie, 1877, p. 470.

The special instruments required are a speculum oris, or two blunt hooks to be placed at the angles of the mouth and fastened together by a rubber band passing behind the head, pronged forceps with long handles, curved needles of the pattern selected, a periosteum elevator bent at a right angle on the flat, a small knife similarly bent, and sponges on long handles.

The edges of the perforation or fissure are first freshened by the removal of a strip one or two millimetres thick. An incision is then made on each side close to the gum, extending from the last molar tooth forward as far as may be necessary, and exposing the bone throughout. The elevator is introduced into this incision and the periosteum separated from without inward, care being taken not to injure the palatine arteries at the anterior and posterior palatine foramina.

If the cleft involves the soft palate its sides will be found to round off toward the hamular processes, and the velum to be tightly adherent to the posterior portion. The flaps cannot be brought together until the attachments of the two halves of the velum at these points are entirely separated, a step which may be accomplished by means of a small, curved, sharp elevator introduced through the lateral incisions, or by the bent knife introduced through the fissure.

The bleeding during this stage of the operation is very free, but, as Ehrmann[1] has remarked, usually ceases as soon as the flaps are completely liberated If it continues pressure should be made for a few moments with the finger, or ice applied. Trélat carries his incisions further back, stopping from one-fourth to one-half an inch behind the posterior border of the hard palate, and entirely disregarding the posterior palatine artery.

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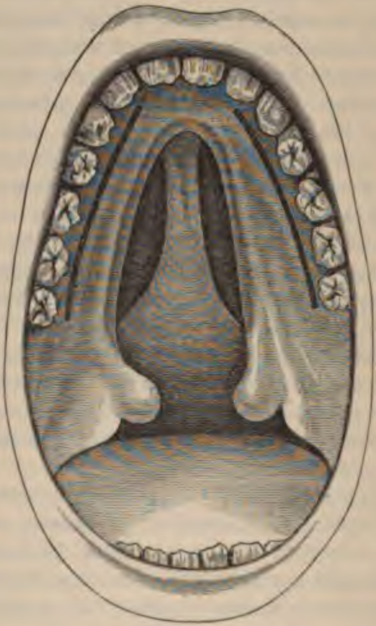
[1] Mémoires de l'Acad. de Médecine, vol. xxxi.

The flaps are brought together in the median line and the sutures applied, beginning at the anterior extremity of the cleft. The sutures should be left in at least four days and then removed, not all at once, but by instalments.

FIG. 198.



Incisions in uranoplasty.

If the fissure is unilateral, the vomer remaining attached on the other side, Von Langenbeck recommends that the lateral incision along the gum should be made only upon the side occupied by the fissure. The flap on the other side should be dissected up from the median line outward.

If the fissure extends through the dental arch and is wide at the point, Rouge[1] recommends that one of the flaps should be detached in front also and swung in sideways upon the posterior attachment as a centre.

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[1] L'Uranoplastie et les Divisions Congénit. du Palais, 1871, p. 108.

Fergusson's Osteoplastic Method.[1]—In 1874 Sir William Fergusson described a plan which he had successfully employed to close gaps in the hard palate left by the partial failure of a previous operation, adding that it was equally applicable to those cases, frequent in his own experience, in which the front part of the cleft had been left untouched. He made an incision down to the bone on each side of the cleft, midway between it and the alveolar process, and overlapping it a little at each end, and then with a chisel cut through the bone at the bottom of the incisions. According to Lannelongue,[2] the flow of blood at this stage of the operation is very great, but is easily controlled by pressure. The flaps are then brought together in the median line and fastened with sutures. Fergusson was in the habit of passing the sutures through the bone, and for this purpose drilled holes along the sides of the cleft before he made the incisions. Shortly before his death, he gave up sutures entirely and kept the flaps together by plugging the lateral incisions with lint. Lannelongue considers the lint dangerous, and uses sutures passed through the mucous membrane only.

Lannelongue's Method (nasal flap).—Lannelongue has closed several clefts involving only the hard palate by means of a rectangular flap brought down from the side of the septum of the nose. The flap is marked out by a horizontal and two vertical incisions—the former parallel to the edge of the cleft and at a suitable distance above it, the latter extending downward from each end of the horizontal one to the angles of the cleft. The flap, composed entirely of the mucous membrane of the septum, is dissected from above downward with a curved blunt elevator and left adherent at its inferior border. The opposite edge of the cleft is then freshened by the removal of a superficial strip one-quarter of an inch broad, and the upper border of the flap attached to it with sutures.

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[1] British Medical Journal, April 4, 1874, and Braithwaite's Retrospect, vol. lxix. p. 217.

[2] Bulletins de la Société de Chirurgie, 1877, p. 472.

STAPHYLOPLASTY.

Schoenborn describes[1] a plastic operation successfully performed by him upon a girl seventeen years old, affected with congenital fissure of both hard and soft palates extending to the anterior palatine foramen, the halves of the velum being very deficient.

The patient was anæsthetized, tracheotomy performed, and a tampon-canula[2] inserted. After having pared the edges of the fissures he took a flap four or five centimetres long and two centimetres broad from the posterior wall of the pharynx, its base directed downward, its apex situated as high as possible, so that it would reach to the posterior edge of the hard palate without the slightest stretching.

The flap was composed of the mucous membrane and underlying muscle. Its dissection is difficult, and requires a long knife with a cutting edge two centimetres long turned down at right angles to the stem. The blade should be sharp on both edges, and it is well to have two such knives, one blunt-, the other sharp-pointed.

The upper end of the flap was caught up with a hook, and the dissection made from above downward, the knife being kept in the cellular tissue between the muscle and bone, and its edge always turned away from the flap.

The fibro-mucosa of the hard palate was then freely dissected up in the usual manner (Von Langenbeck's method) until it and the soft palate had been made sufficiently movable. The upper corners of the flap were then cut off, giving it a triangular shape, and it was brought in between the halves of the soft palate and fastened there with five points of suture. The fissure in the hard palate was closed with three points.

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[1] Ueber eine neue methode der Staphylorrhaphie. Langenbeck's Archiv, 1876, vol. xix. p. 527.

[2] A tracheotomy tube, the middle portion of which is enveloped in a rubber pouch which can be expanded so as to fill the trachea and prevent any liquids from finding their way down beside it, the patient meanwhile getting his supply of air through the tube.

The tampon-canula was replaced next day by a silver one. Swallowing was very difficult for a few days; suppuration and flow of mucus very abundant. The sutures were taken out on the fifth day. Union was complete on the right side and upper part of the left, but had failed for a distance of one centimetre between the tip of the uvula and the flap on the left side, and of three centimetres in the hard palate. The latter was closed by another operation (Langenbeck's) in January, 1875.

The tone of the voice and the distinctness of articulation were immensely improved from the first, and after a few days there was no difficulty in swallowing or in breathing through the nose.

This operation was designed to meet a special indication, of which mention is not often made. It is well known that the nasal quality of the voice often persists after a fissure has been completely closed, and the cause has been supposed to lie in the fact that the soft palate is so short and tense that it cannot be brought into contact with the posterior wall of the pharynx. Passavant proposed to meet the difficulty by establishing permanent adhesion between the velum and pharynx, basing the proposition upon cases of such adhesion observed by himself in which the objectionable nasal quality was absent from the voice. A more extensive experience, however, has shown that Passavant was in error, or that his observations were incomplete. If the adhesion is complete, or nearly so, the quality of the voice is seriously affected, and other functional troubles are occasioned. It is probable that the good result in Schoenborn's case was due to two causes: free communication left between the upper and lower parts of the pharynx on each side of the flap, and ability to move the two halves of the palate at will, although only to a limited extent. The method seems to be worth further trial.

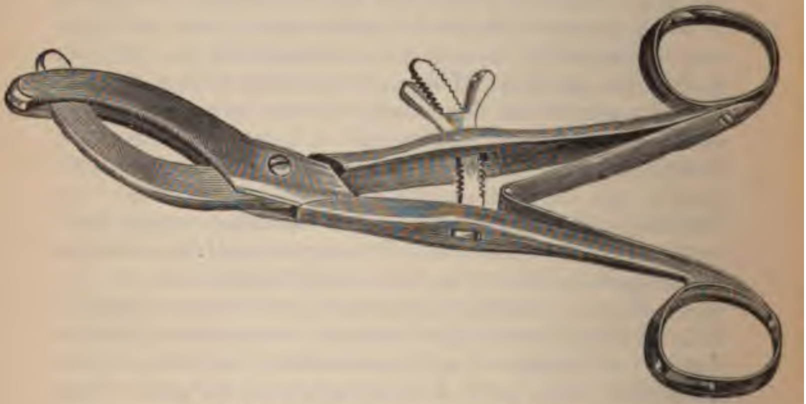
EXCISION OF THE TONGUE.

Excision, partial or complete, may be rendered necessary by hypertrophy of the tongue, or by the presence of a tumor.

Sédillot[1] mentions a case of hypertrophy in which the tongue projected three finger-breadths beyond the lips, and had bent down the anterior portion of the lower jaw to such an extent that, when the upper and lower molar teeth were in contact, the distance between the incisors in the median line was more than an inch. He removed the projecting part of the tongue by a V-shaped incision, the apex directed backward in the median line, and brought the sides together with sutures. Recovery was complete and prompt.

Excision may be performed by means of the ligature, knife, écraseur, or galvano-cautery. The use of a ligature, slowly tightened every day, has fallen into disuse since the invention of the écraseur; it is very tedious and painful, and the tongue is liable to swell enormously during the process.

FIG. 199.



Lee's clamp to prevent bleeding from the tongue.

The use of the knife exposes to severe hemorrhage unless the portion removed is small and favorably situated. Preliminary ligature of one or both lingual arteries is sometimes employed. Mr. Henry Lee has devised a clamp (Fig. 199) by which hemorrhage from the anterior portion of the tongue can be completely controlled.

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[1] Médecine Opératoire, vol. ii. p. 33.

Langenbuck[1] has devised a method of so placing two temporary ligatures upon the tongue that bleeding is entirely prevented during the removal by the knife of any portion of the anterior half or even two-thirds of the member. He enters the point of a well curved needle carrying a stout ligature a little to the left of the median line of the tongue behind the part which is to be removed, passes it deeply down through the substance of the tongue, and brings it out on the right side through the floor of the mouth so as to include the branches of the lingual artery in its loop. To prevent slipping, the needle is then passed through the edge of the tongue; another is passed in the same manner on the opposite side, and each tied tightly. The ends may then be used to draw the tongue forward.

It has also been suggested, that, when it is necessary to operate very far back upon the tongue, its base can be brought forward by dislocating the lower jaw downward and forward simultaneously on both sides.

The tongue is drawn well forward, the tumor or portion to be removed seized with double pronged forceps and rapidly excised by a **V**-shaped incision made with a blunt-pointed bistoury so as to avoid injury to the vessels in the floor of the mouth; all bleeding points are then secured and the sides of the wound brought together with sutures.

If a larger portion, say a lateral half, of the tongue is to be removed, the operation may be done as follows: Two stout ligatures are passed through the tip, one on each side of the median line, to be used to draw the organ forward; the tip then raised, the frænum cut with scissors, and the scissors then pushed along under the tongue and mucous membrane to free them as far back as necessary. Then the tongue is split along the median line, from before backward, completely freed from the underlying parts by tearing with the finger, the mucous membrane of the floor divided with the scissors, and the posterior section made with knife or scissors or with the écraseur.

Both halves can be removed in like manner, without splitting, by freeing below, and cutting first on one side of the floor and then on the other, and tying each lingual artery when it is divided in the wound.

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[1] Archiv für Klinische Chirurgie, vol. xxii. part I., 1878, p. 72.

Regnoli, of Pisa, published in 1838 the description of a method by which he successfully removed the anterior portion of the tongue. He made a semicircular incision through the skin along the lower border of the jaw, beginning and ending at the angles, and added a second one to it in the median line, extending to the hyoid bone. The tegumentary flaps were dissected back, and the muscles divided at their attachments to the inferior maxilla. The tongue was then drawn down through the large opening thus made, its anterior portion readily excised, and the wound closed. Billroth has revived and modified Regnoli's operation and employed it in several cases. It has the advantage of furnishing free drainage, allowing the wound to be treated antiseptically, and facilitating the removal of implicated lymphatic glands. A curved incision, extending 1 to 1½ inches on each side of the symphysis, is made in the under margin of the jaw and carried down to the bone, and then it is enlarged at each end for an inch downward and outward. The periosteum and muscular attachments are separated in front from the inside of the jaw, the mouth opened by division of the soft parts at the gums, and the tongue drawn out through the cut.

Lateral Supra-hyoid Method. Kocher.[1]—This method has for its object the very thorough removal of all diseased tissues of the tongue and pharynx and all infected glands in the neck. Preliminary laryngo-tracheotomy is necessary to facilitate the operation and permit antiseptic treatment of the wound. The mouth is disinfected by washing with a salicylic and borax solution.

The incision is made from the under border of the lower jaw near the symphysis, in the direction of the anterior belly of the digastric, to the hyoid bone, thence backward to the anterior border of the sterno-cleido-mastoid, and then upward along it to or above the angle of the jaw; after division of the platysma and fascia the triangular flap is turned up.

The submaxillary fossa is then emptied by removal of the submaxillary and diseased lymphatic glands, the facial and lingual arteries and veins having been divided between double ligatures.

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[1] Deutsche Zeitschrift für Chir., 1880, vol. 134.

The larynx and œsophagus are then covered with a large sponge forced in behind the tongue, and an incision made into the floor of the mouth by cutting through the mylohyoid muscle close to the jaw, and carried along the bone as far as may be necessary.

The tongue is now freely accessible through the wound, and can be drawn out through it and split, and cut off as near its base as is desirable, or it can be entirely removed in the same manner, the opposite lingual artery being readily secured when divided. The side, and even the posterior part of the pharynx, are also accessible.

The tracheotomy tube should be retained, the wound packed with antiseptic gauze, and the patient fed through an œsophagus tube.

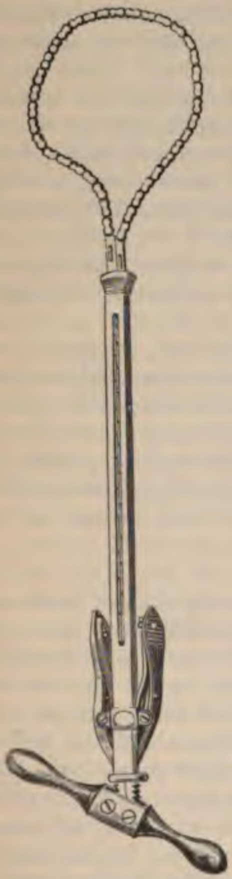
Sédillot, commenting upon Regnoli's case, expresses the opinion that the excision could have been accomplished quite as readily through the mouth, and, as he also found by experiments upon the cadaver that the tongue cannot be brought far enough forward through such an opening to facilitate excision at or near its base, he suggested and employed division of the inferior maxilla in the median line as a preliminary operation.

Sédillot's Method.—One of the median incisor teeth on the lower jaw having been drawn, an incision is made in the median line from the free border of the lower lip to the hyoid bone, and the jaw sawn through in the line of the incision, or, better, by two oblique lines forming a <, the apex directed to one side. The attachments of the genio-hyo-glossus muscles to the bone are next divided, the two halves of the jaw drawn apart, the tongue pulled forward and to one side, and its attachments to the hyoid bone divided on the other side, in doing which the lingual artery is divided and must be tied at once. The tissues on the other side are then divided in a similar manner, and the other lingual artery having been tied the remaining attachments are severed and the tongue removed.

The divided maxilla is fastened together again with silver sutures passed through holes pierced in it with a drill, the sides of the incision in the lip accurately adjusted to each other, and the lower angle of the wound left open for drainage.

The bone has sometimes been divided in the side instead of in the median line.

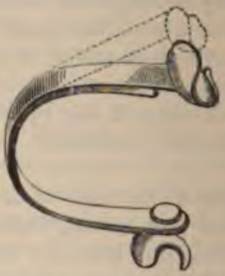
Fig. 200.



Ecraseur.

Removal by the Écraseur (Fig. 200).—The chain of the écraseur, a stout wire, or a whip-cord is passed about the tongue or its attachments at the selected point by means of a needle and thread or a trocar and canula, and slowly tightened until the parts included in the loop are cut through. As the operation is comparatively bloodless, anæsthesia should be used and the mouth held open by a gag. Hutchinson's gag (Fig. 201) is very convenient and takes up but little room.

Fig. 201.



Hutchinson's gag.

Many different ways have been suggested for passing the wire or chain. For removal of the anterior portion a needle carrying a ligature may be passed transversely under the tongue and used to conduct a chain below it and back across its dorsum. After the tongue has been thus divided transversely the chain is passed again through the incision, including in its loop the inferior attachments of the anterior portion. Or the first ligature may be double and two écraseurs used simultaneously.

Mirault carried a double ligature through the centre of the tongue from below upward by means of a needle passed through a small incision in the skin in the median line of the supra-hyoid region. The ligature was then cut in two, each end carried around a lateral half of the tongue and brought out through the original opening. A third ligature was then carried horizontally about the inferior attachments of the portion to be removed.

Cloquet removed a lateral portion of the tongue by passing a double ligature in the manner just described, and placing one of the loops in an antero-posterior position so that it divided the tongue along the median line.

Sir James Paget drew the tongue forward, divided the mucous membrane and the soft parts of the floor of the mouth close to the bone, including the attachments of the genio-hyo-glossi to the symphysis, and then passed the chain of the écraseur around the root of the tongue as low down as possible, so as to encircle it and all the remaining inferior attachments.

The galvano-cautery is used either in the form of a knife or as the wire of an écraseur; no additional directions are required beyond the caution that the temperature should be raised to red heat only. At a higher temperature the parts are divided more rapidly, and bleeding is likely to occur.

DIVISION OF THE FRÆNUM.

The tip of the tongue is raised upon the handle of a director, in the slit of which the frænum is engaged, and divided with curved scissors close to the director. Only the semi-transparent edge of the constricting band should be cut, and then the rest torn by pressing the tongue up toward the roof of the mouth. If the ranine vessels should chance to be divided the bleeding can be controlled by touching the points with nitrate of silver or, if necessary, with the actual cautery. J. L. Petit reported a case of suffocation caused by the tongue falling back upon the glottis after division of the frænum, and Guérin mentions another.

RANULA.

The anterior wall of the cyst should be caught up with toothed forceps and excised. A director should be passed at intervals between the sides of the incision to prevent re-union, and the filling up of the sac may be hastened by painting its interior with nitric acid or tincture of iodine. In some cases it is sufficient to pass a thread or wire seton through the cyst.

SALIVARY FISTULA.

Salivary fistula communicating directly with portions of the parotid gland can usually be closed by cauterization and compression, but when the fistula communicates with Steno's duct the cure is much more difficult. If the distal portion of the duct is still permeable a leaden wire may be passed through it from the mouth into the proximal portion of the duct. The saliva will follow the wire, and if the fistula does not close spontaneously its edges should be pared and brought together with sutures. The orifice of the duct is readily found opposite the second upper molar tooth.

When the distal portion of the duct is obliterated either one of two methods may be employed. The first is that of Deguise, and consists in the formation of a new channel in the cheek for the saliva; the second is that of Prof. Van Buren, and consists in the bodily transfer of the fistulous orifice from the outer to the inner surface of the cheek.

Deguise's Method.—Deguise made a puncture through the fistulous opening obliquely backward to the inner surface of the cheek and passed one end of a leaden wire through it; he next made through the same opening a second puncture directed obliquely forward, brought the other end of the wire through it and tied the two ends together. The loop of the wire being thus drawn into the fistula the saliva followed its two branches into the mouth, and the fistula healed at once. Some surgeons use a silk ligature and tie it tightly so as to cut through the tissues included in the loop.

Prof. Van Buren[1] cured a salivary fistula, the result of a gunshot wound, by passing two fine silver wires through the skin at opposite points on its edge, then isolating the duct and fistulous opening for half an inch by dissection backward from the latter, making an incision through the wound to the inner side of the cheek, drawing the fistulous opening through it, and fastening it there by means of the wires. The gap left on the cheek was then closed with fine silver sutures.

The duct was so short, the fistula being an inch behind the anterior margin of the masseter, that it could not be brought quite to the inner surface of the cheek. The wires, however, which were left in place until the fifth week, kept open a track, which became permanent, for the passage of the saliva from the end of the duct to the mouth.

CHAPTER IV.

OPERATIONS PERFORMED UPON THE NECK.

BRONCHOTOMY.

THIS is a general term covering operations undertaken to open the larynx or cervical portion of the trachea. These operations are: *Laryngotomy*, *tracheotomy*, and *laryngo-tracheotomy*. Laryngotomy is further subdivided into *sub-hyoid laryngotomy* (called *supra-laryngeal bronchotomy* by Sédillot, and *indirect laryngotomy* by Planchon), *thyroid laryngotomy*, and *crico-thyroid laryngotomy*. The names indicate the points at which the opening is made into the air-passages.

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[1] New York Medical Journal, vol. i. p. 53, and Contributions to Practical Surgery, 1865, p. 205.

Sub-hyoid Laryngotomy.—This operation, originally performed upon animals by Bichat for the purpose of studying the movements of the vocal cords, was afterwards proposed by Vidal to give access to an abscess situated in the glotto-epiglottidean folds, and by Malgaigne to allow the removal of a foreign body lodged in the upper part of the larynx. It is also applicable to the removal of polyps situated at the same point and not accessible through the mouth. Follin thus removed ten from the anterior surface of the arytenoid cartilages.

A transverse incision two inches long, its centre in the median line, is made through the skin immediately below the hyoid bone, and the platysma, sterno-hyoid muscles, and thyro-hyoid membrane divided. The mucous membrane lying between the epiglottis and the base of the tongue then presents in the incision, is drawn downward with forceps, and opened with the knife or scissors. The epiglottis is then seized with a hook or pronged forceps and drawn out through the wound, freely exposing the larynx to view.

Velpeau made the first incision in the median line, divided the thyro-hyoid membrane transversely, and then plunged the knife backward and downward, making a vertical incision in the base of the epiglottis through which he passed the blades of a pair of forceps and withdrew the foreign body.

Thyroïd Laryngotomy.—In this operation the thyroid cartilage is divided vertically in the median line, between the anterior attachments of the vocal cords. It is suitable for the removal of foreign bodies or polyps from the interior of the larynx.

Steadying the larynx with the thumb and forefinger of his left hand, the surgeon makes an incision along the projecting angle of the thyroid cartilage in the median line, from its upper border to the cricoid cartilage. As soon as the crico-thyroid membrane is exposed, he makes a small opening in it near its upper border and passes one blade of a strong blunt-pointed pair of scissors through it to the upper border of the larynx, keeping exactly in the median line, and thus divides the thyroid cartilage throughout its entire length. Or a grooved director may be passed through the opening made in the crico-thyroid membrane, and the cartilage divided upon it with a curved bistoury. Or, again, the division may be made with the knife, layer by layer, from before backward.

Crico-thyroid Laryngotomy.—In this operation the opening is made in the crico-thyroid membrane. The French writers, Sédillot, Dubrueil, Chauvel, speak of this method as having been entirely abandoned because the opening cannot be made sufficiently large. Holmes, on the other hand, considers it suitable in all cases in which only the vocal cords or the tissues above them are involved, and says it is practised in spasm of the glottis from any cause, in erysipelatous affections spreading down the throat, and in cases of foreign body lodged in or above the glottis. If the opening proves to be too small it can be enlarged downward through the cricoid cartilage (laryngo-tracheotomy). The operation may be required in cases of urgency when no tube is at hand. A pair of forceps or scissors, a hair-pin, or pieces of bent wire will suffice to keep the wound open, and the incision can be made with a penknife.

Operation.—Dorsal decubitus, shoulders raised upon a cushion or narrow pillow so that the head may fall back and keep the throat tense. The surgeon, standing at the patient's right side, fixes the larynx with his left thumb and middle finger placed on either side, and the index upon its upper border, and makes a cutaneous incision in the median line corresponding to the crico-thyroid membrane. He draws the sterno-thyroid muscles apart, lays bare the membrane, and divides it transversely or vertically; in the latter case the incision should begin a short distance below the inferior border of the thyroid cartilage, so as to avoid a small artery which crosses at that point, and extend to the cricoid cartilage. (For the method of inserting the canula see *Tracheotomy.*)

Laryngo-tracheotomy.—The opening occupies part of the crico-thyroid membrane, the cricoid cartilage, and the first two or three rings of the trachea. The upper border of the isthmus of the thyroid usually corresponds to the second ring of the trachea; it should not be divided. In children under six years it commonly rises to the lower border of the cricoid cartilage.

Dorsal decubitus, with shoulders raised, head thrown back, and neck slightly stretched. The larynx is fixed as for crico-thyroid laryngotomy, and an incision made through the skin exactly in the median line from the middle of the thyroid cartilage to about one inch below the cricoid. The muscles are carefully drawn apart, the isthmus of the thyroid depressed if necessary, after nicking and tearing with blunt hooks the suspensory fascia at its upper border, the trachea steadied and drawn upward with a sharp hook thrust into the upper part of the crico-thyroid membrane, and the point of the bistoury entered close below the hook and made to cut downward through the cricoid cartilage and one or two rings of the trachea. The edges of the incision are then held apart and the canula introduced, or the forceps if the operation has been undertaken with a view to the removal of a foreign body or a polyp.

De Saint Germain's Method.—Dorsal decubitus, shoulders raised, neck extended. The surgeon feels for the cricoid and thyroid cartilages, and the depression between them. Then, standing upon the patient's right side, he places his left thumb and middle finger on either side of the larynx, and by pressing them in between it and the vertebral column, pushes the larynx forward, makes tense the skin covering it, and at the same time marks the situation of the lower border of the thyroid cartilage with the nail of his left forefinger.

The knife, a straight sharp-pointed bistoury, is held like a pen, its back directed upward, and the middle finger so placed upon its side as to limit to half an inch the depth to which the point can penetrate. It is then entered with a quick sharp stab in the median line close against the nail of the left forefinger and made to cut downward with a sawing motion through the cricoid cartilage and one or two tracheal rings, care being taken to make the incision in the skin fully as long as that in the trachea. The wound is held open with a "dilator," and the canula introduced between its branches; the pressure of the latter is usually sufficient to arrest hemorrhage, but ligatures can be easily applied if necessary. In only one case out of ninety-seven did Saint Germain injure the posterior wall of the trachea, and in only three did hemorrhage occur.[1]

Tracheotomy.—The trachea may be opened at any point between the cricoid cartilage and the upper border of the sternum, a distance averaging in the adult from two and one-half to three inches, in the child under ten years of age from one and one-half to two and one-half inches. Its course is obliquely backward as well as downward, so that while its upper end is almost subcutaneous it becomes deeply placed before it passes behind the sternum. It is crossed at its upper end by the isthmus of the thyroid gland, the breadth, thickness, and vascularity of which vary within very wide limits, although its upper border usually corresponds to the second ring of the trachea. A communicating branch uniting the two inferior thyroid arteries crosses just below the lower border of the isthmus. The lower portion is covered anteriorly by the thyroid veins, always greatly distended when the respiration is obstructed, and by the thymus gland in children under two years of age, and occasionally in unhealthy older ones.

To the dangers depending upon the normal arrangement of the parts are added those of not infrequent anomalies in the origin and course of the arteries and veins. Thus, the left brachio-cephalic vein may cross the trachea well above the sternum, the left carotid may arise from the innominate, and sometimes an inferior thyroid artery is given off from the transverse portion of the arch of the aorta, and ascends along the anterior surface of the trachea in the median line. Finally, an aneurism of the innominate, or of the arch of the aorta, may rise in front of this portion of the trachea.

Operation.—The patient is placed upon his back with shoulders raised and head thrown back. A trustworthy assistant, standing behind the head, holds it firmly in a straight line with the body; others control the patient's limbs if he has not been anæsthetized. The surgeon, standing at the patient's right side, recognizes with his finger the hyoid bone and thyroid and cricoid cartilages, and, marking with his left forefinger the lower border of the cricoid cartilage, makes an incision downward from it in the median line from one and one-half to two inches in length, according to the size of the patient. He carries the incision through the skin and fascia, separates the sterno-hyoid and sterno-thyroid muscles with the handle of his knife, and lays bare the isthmus of the thyroid. If any large veins are encountered, they must be carefully drawn aside or divided between two ligatures, but bleeding from smaller ones may be safely disregarded, for, as Trousseau pointed out, it will cease as soon as the trachea is opened, and the venous congestion relieved by the admission of air to the lungs.

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[1] Bull. de la Société de Chirurgie, 1877, pp. 271 and 327.

It is well to have one or two assistants hold the sides of the incision apart during the dissection, if they can be depended upon to do so without disturbing the relations of the parts by drawing too forcibly toward one side or the other.

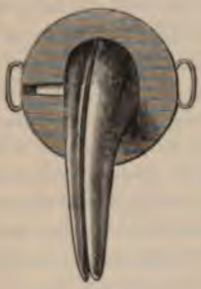
The isthmus of the thyroid is next drawn upward with a blunt hook, and three or four rings of the trachea exposed below it, and divided from below upward. If for any reason it is desirable to make the incision higher up, or if the isthmus is unusually broad, it may be divided between two ligatures, in which case the incision of the trachea should be made from the lower border of the cricoid cartilage downward.

The incision in the trachea should always be free enough to admit the canula readily, and should be made by a quick thrust with a sharp-pointed knife, which must be prevented from penetrating too deeply at first, by holding it close to its point. After the puncture has been thus made, it is enlarged by gentle sawing movements of the knife, or with scissors.

The knife is retained in the trachea as a guide, until the dilator or bivalve canula (Figs. 202 and 203) has been introduced. The best dilator is the three-bladed one; it is introduced closed, its blades then expanded, and the permanent canula passed in between them. The canula should be curved, double to facilitate cleaning, and with an opening on its convexity, through which the expired air can pass to the larynx.

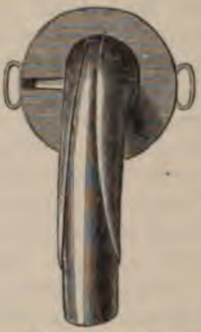
Some surgeons steady the trachea by drawing it toward the chin with a tenaculum introduced at the lower edge of the cricoid cartilage. Gurdon Buck used for this purpose a rather narrow lance-shaped knife, bent at a right angle on the flat, and also grooved on the back for use as a director.

FIG. 202.



Bivalve canula closed.

FIG. 203.



Bivalve canula with tube in place.

Galvano- or Thermo-cautery.—The danger of hemorrhage, especially in the adult, has led many surgeons to use the galvano- or thermo-cautery. Its hemostatic advantages, however, are offset by a large eschar which it causes, and the possible necrosis of the tracheal cartilages.[1] The cautery should be used only to divide the soft parts, the trachea should be opened with the knife. Saint Germain has also sought to prevent hemorrhage by making the incision with a red-hot bistoury.

ŒSOPHAGOTOMY.

The œsophagus begins in front of the sixth cervical vertebra in the median line, or just behind the cricoid cartilage;

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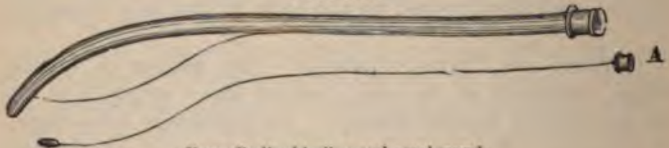
[1] See the discussion in the Société de Chirurgie, May 9 to June 13, 1877.

at first it inclines slightly toward the left, then returns to the median line as it passes behind the sternum, inclines to the right at the arch of the aorta, and again to the left as it approaches the diaphragm. The left recurrent laryngeal nerve lies between its cervical portion and the trachea, the right recurrent nerve lies upon its outer side. It is covered anteriorly by the trachea and left lobe of the thyroid gland, and crossed by the left inferior thyroid artery and vein. The guide to it is the trachea. The operation of external œsophagotomy may be required for the relief of stricture, or the removal of a foreign body. In the former case, it may be performed above or at the level of the stricture for the purpose of dividing or dilating it, or below the stricture so as to allow the introduction of food into the stomach. The left side of the œsophagus is more accessible in the neck than the right, and the incision may be made in the median line or parallel to the inner border of the sterno-cleido-mastoid muscle. As the walls of the œsophagus are flaccid, a guide should be used if it is possible to introduce one. The best one is the instrument known as Vacca-Berlinghieri's sound (Fig. 204). It is a hollow metallic instrument, curved at one end like a urethral sound, but to a less degree, with a long opening in the concavity or on the left side, extending not quite to the end. Within the sound is an elastic staff, the side of which can be made to project through the opening and distend the œsophagus, its point being engaged in the cul-de-sac at the extremity of the sound. In some cases the foreign body can be used as a guide.

FIG. 204.



Vacca-Berlinghieri's œsophageal sound.

Lateral Incision.—Dorsal decubitus, head extended, face turned slightly to the right. The surgeon, standing at the patient's left, makes an incision through the skin, subcutaneous cellular tissue, and the platysma a little on the inner side of the inner border of the sterno-cleido-mastoid from a point one inch above the sternum to the level of the upper border of the thyroid cartilage. If the external or anterior jugular is encountered, it must be drawn aside or divided between two ligatures. The fascia is then divided, the omo-hyoid muscle drawn aside, and then the side of the thyroid gland followed downward. The sterno-cleido-mastoid and the great vessels are drawn outward with a blunt hook, the trachea and thyroid gland to the right, and then the surgeon, working with his fingers or blunt instruments, separates the tissues at the bottom of the wound and exposes the œsophagus, which can be recognized by its flattened appearance and muscular wall. If more room is needed, the sternal head of the sterno-cleido-mastoid must be divided. Vacca's sound is then introduced through the mouth, its elastic staff projected through the lateral opening so as to distend the œsophagus, and recognized by the finger at the bottom of the wound. The surgeon, having satisfied himself that the recurrent laryngeal nerve and inferior thyroid artery are out of the way, punctures the œsophagus by picking it up with two hooks or toothed forceps and cutting between them, and enlarges the opening with scissors or a blunt-pointed bistoury.

Median Incision.—The incision is the same as in tracheotomy. After the trachea has been exposed in the median line, the surgeon separates it on the left side with a director from the sterno-thyroid and sterno-hyoid muscles, and opens the œsophagus on the outer side of the recurrent laryngeal nerve.

CHAPTER V.

OPERATIONS UPON THE THORAX.

AMPUTATION OF THE BREAST.

THE patient is placed upon her back, inclined somewhat toward the opposite side, and the arm abducted so as to make the skin and pectoral muscle tense. Two curved incisions are made, one on each side of the nipple, inclosing an elliptical strip of skin of greater or less breadth according to circumstances, the long axis of which is directed toward the axilla; that is, upward and backward. The upper and lower skin flaps are then dissected off the anterior surface of the gland, its upper border turned, exposing the pectoral muscle, if necessary, and the loose cellular tissue between it and the muscle rapidly divided with a few strokes of the knife, beginning at the upper border of the inner angle, while the gland is drawn away from the chest wall, and the removal completed along the lower incision, or at the axillary angle of the wound.

Bleeding during the operation must be controlled by clamps upon the bleeding points, and the vessels secured afterward with ligatures or by torsion.

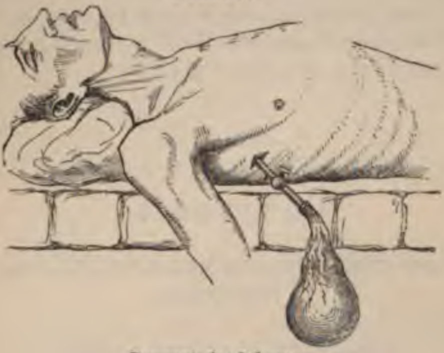
If the axillary glands are involved, the incision must be extended upward across the axilla to the arm, and the glands dissected off the vessels and removed *en masse*, with the fat and connective tissue interposed between them and the breast.

PARACENTESIS OF THE THORAX.

Each of the lower posterior intercostal arteries enters its corresponding intercostal space near the spinal column, and passes obliquely from below upward across the space to shelter itself in a groove on the inner side of the lower border of the upper rib. It occupies this groove until it reaches the anterior third of the space, when it leaves it to anastomose with the branches of the anterior intercostal artery coming from the internal mammary. At this point, however, it is so small that its division is not of much consequence. The only part of its course where its injury is to be feared is in the posterior third of the intercostal space before it has passed behind the lip of the rib. Consequently, if an opening is to be made into the pleural cavity, either with a knife or trocar, a point in the middle third of one of the intercostal spaces should be selected, preferably the seventh, certainly not higher than the sixth, nor lower than the eighth on the right side, the ninth on the left.

After determining the position of the intercostal space, often a matter of considerable difficulty in consequence of the infiltration of the parts, make an incision parallel to it, one or one and one-half inches in length. Divide the tissues layer by layer, until the rib can be distinctly felt with the finger introduced into the wound. Place the end of the finger upon the upper border of the lower rib, and, keeping the knife close to the border, divide the muscles and pleura.

FIG. 205.



Paracentesis of thorax.

If a trocar or the aspirator is used, it must be thrust in with a sharp push so as certainly to penetrate the pleura, which is often thick and tough. The outer end of the canula should be wrapped in a long sleeve of moistened gold-beater's skin, which will hang down over its orifice, and, while permitting the escape of the pus, will prevent the entrance of the air (Fig. 205); or, as suggested by Dr. Flint, a Davidson syringe can be attached to the trocar.

See also Resection of the ribs, page 192.

PARACENTESIS OF THE PERICARDIUM.

Normally the pericardium is in contact with the chest wall only in the median line under the sternum; but when its sac is distended with liquid the area of contact becomes much larger, especially by extension downward and to the [illegible] heart is at the same time pressed upward and backward. The limits of the pericardium can be ascertained with great accuracy by percussion and auscultation, and this should always be done before puncturing. At the point selected for puncture the pulsations of the heart should be imperceptible, or at least very faint, and it should be absolutely flat on percussion. It should also be remembered that the internal mammary artery runs parallel to the side of the sternum, and a finger's breadth from it.

If the knife is used the tissues must be divided layer by layer, and the finger should always be introduced into the wound before the pericardium itself is incised, to make sure that the heart is not in contact with it.

CHAPTER VI.

OPERATIONS UPON THE ABDOMINAL WALL, STOMACH, AND INTESTINES.

PARACENTESIS OF THE ABDOMEN.

In order to avoid injury to the different viscera, and especially to the internal epigastric artery, which runs from the middle of Poupart's ligament toward the umbilicus, the puncture should be made either in the median line midway between the umbilicus and the symphysis pubis, or midway between the umbilicus and the anterior superior spine of the ilium. The instrument used is a trocar and canula or the needle of an aspirator. The depth to which it shall be allowed to penetrate is regulated by the finger placed upon its side, and it should be plunged in sharply, without a preliminary incision, at the selected point, which should be absolutely flat upon percussion. As there is a possibility of syncope occurring during the operation, in consequence of the withdrawal of pressure, it is prudent first to pass a broad, many-tailed flannel bandage about the abdomen, crossing its ends behind, so that an assistant standing at each side can draw upon them and tighten the bandage as the liquid escapes. It is usually sufficient, however, to have an assistant make steady pressure with one hand on each side of the abdomen. During the operation the patient should be seated or inclined toward one side.

Should hemorrhage ensue, the attempt must first be made to control it by the pressure of the canula or of a larger gum catheter introduced through the puncture. This failing, the entire thickness of the abdominal wall must be pinched up and compressed, or, in extreme cases, an acupressure needle or harelip pin passed across the course of the bleeding vessel and pressure made by a twisted suture thrown around its ends.

When it is necessary to practise paracentesis upon a pregnant woman, Ollivier recommends the selection of the neighborhood of the umbilicus for the puncture; Scarpa preferred the left hypochondrium, Velpeau the left flank.

GASTROTOMY AND GASTROSTOMY.

The word *gastrotomy*, which was first used to indicate an operation by which an incision was made through the abdominal walls, whether for the removal of a tumor, the relief of strangulation of the intestines, or the opening of the stomach, is now generally restricted to the latter, that is, to an opening made through the abdominal wall into the cavity of the stomach. When the opening is made a permanent one, the term *gastrostomy* (γαστὴρ stomach, and στὸμα mouth) is used. *Laparotomy* (λοπάρα the flank), a term originally applied to the operation for the relief of lumbar hernia, is now generally substituted for gastrotomy in the sense formerly given to that word, to indicate an incision through the abdominal walls. It is sometimes used in combination, also, as laparo-enterotomy,—ileotomy,—typhlotomy,—colotomy, to indicate incision of the large or small intestine, but the use of the terms enterotomy and colotomy in this sense is much more general.

The operation of gastrotomy, the earliest recorded example of which dates back to the first half of the seventeenth century, has been a very successful one. Of thirteen cases collected by various writers[1] only one terminated fatally, and in that case the cause of death is not known. Gastrostomy, on the other hand, is a much more recent and very fatal operation. The editor of the *Gazette Hebdomadaire*, May, 1876, mentions twenty-two cases, all of which terminated fatally. This discouraging series has since been broken by Verneuil's successful case, reported in the same journal October 27, 1876, but this again was followed by two fatal ones, one by Callender, the other by Lannelongue; perhaps the latter of these should be classed as a success, for the patient survived the operation twenty-six days and died asphyxiated in consequence of the perforation of a bronchus by the cancer, which occupied the œsophagus and led to the operation. As the operative methods are essentially the same in both operations, the cause of this difference in result must be sought elsewhere; and it is not difficult to find. While gastrotomy has always been undertaken for the purpose of removing a foreign body from the stomach of a healthy person, gastrostomy has been performed as a last resource upon individuals reduced by starvation and usually in a condition of cachexia produced by malignant disease. In twenty of the twenty-three fatal cases the œsophagus was obstructed by cancer; in the remaining three the stricture was traumatic, but of doubtful nature; in Verneuil's successful case the stricture was traumatic; in Lannelongue's it was cancerous.[2]

When the stomach is distended, it is in contact with the anterior abdominal wall over quite a large area below the left lobe of the liver; when it is empty, this area of contact becomes very small, and lies between the left lobe of the liver and a transverse line drawn at the level of the anterior end of the ninth rib. The guide to this line, as Tillaux[1] has shown, is the anterior end of the tenth rib, which can be readily felt projecting beyond the border of the cartilages of the false ribs, and can be made to yield a sort of friction sound by rubbing it against the ninth. Sédillot[2] claimed that when the stomach was empty, it was nowhere in contact with the anterior abdominal wall, being separated from it by the liver and transverse colon, and recommended that it should be approached by a crucial incision through the left rectus muscle two or three inches below the xiphoid appendix of the sternum. He passed his finger along the border of the left lobe of the liver to the diaphragm, encountered the stomach there, seized it with pronged forceps introduced along the finger, and drew it up to the incision while pressing the colon downward. Although, as stated, more recent investigations have shown that the normal stomach when empty is still in contact with the anterior abdominal wall, these directions for finding the stomach may be useful in cases where it has been drawn back and bound down to the posterior wall by inflammatory adhesions or neoplasms.

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[1] Eleven of these are given with details in an article by Dr. Pooley, in the Richmond and Louisville Med. Journal, April, 1875.

[2] In 1882 I collected (*Medical Record*, Nov. 1882, p. 665) 93 cases of gastrostomy for obstruction of the œsophagus, of which 18 were cicatricial with 8 deaths, and 75 cancerous; of the latter 54 died within three weeks after the operation, and 20 survived for periods varying from three weeks to eight months, two or three being still alive at the date of the last report. The influence of the enfeebled condition produced by cachexia and starvation upon the result is so marked that if the operation is to be done at all it should be done as early as is practicable.

The place at which the incision should be made into the stomach itself, is determined in gastrotomy somewhat by the position of the foreign body within the viscus; in gastrostomy it should lie midway between the greater and lesser curvatures, and at the junction of the cardiac and pyloric portions. This junction is often rendered plainly visible by an annular narrowing of the stomach at that point, and in any case can be readily determined by its distance from the pylorus, which can be reached with the finger. The curvatures can be recognized by the vessels running along them.

Anæsthesia is usually employed, although a serious objection to its use in gastrostomy is found in the vomiting which it is so likely to cause, and the consequent tearing out of the sutures uniting the stomach to the abdomen. Possibly local anæsthesia by cocaine would be sufficient.

The external incision is the same for both operations. The incision made in the wall of the stomach should, in gastrotomy, be only large enough to permit the removal of the foreign body; if this is small, the elasticity of the parts and the mobility of the mucous membrane may be sufficient to close the opening, and prevent the subsequent escape of the contents of the stomach, but in most cases one or more sutures will be necessary. Sédillot used a continuous suture, and brought the end out through the abdominal wound, which was then closed with interrupted sutures; he found no difficulty in withdrawing the thread a few days later. A silver or catgut suture applied according to one of the methods hereinafter described under the head of suture of the intestines, with both ends cut short, would now be preferred. Labbé united the sides of the incision in the stomach to those of the incision in the abdominal wall, and allowed the gastric fistula thus created to close spontaneously.

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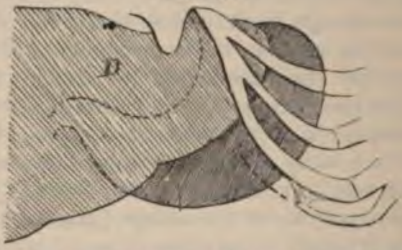
[1] Anatomie Topographique, p. 792.

[2] Méd. Opérat., vol. ii. p. 274.

Operation.—An incision, from one and one-half to two inches in length, is made parallel to, and half an inch on the inner side of, the cartilages of the left false ribs ending below at the level of the base of the cartilage of the ninth rib, which corresponds to the depression that can be felt just above the point of the tenth rib (Fig. 206). The incision is carried down layer by layer, and the peritoneum divided upon a director. The stomach is recognized just below the left lobe of the liver by its white color, smooth surface, and the arrangement of its arteries. If it does not present in the wound, it must be sought for by passing the finger along the border of the liver, and pressing the transverse colon downward.

FIG. 206.



Anatomical relations of the stomach with reference to gastrotomy.

When the stricture is close the stomach and intestines are usually empty and the abdomen deeply sunken by atmospheric pressure. In such cases, when each successive layer is divided it rises from the underlying mass, and when the peritoneum is opened the air rushes in and the abdominal wall rises away from the stomach and becomes level with the sternum and cartilages of the ribs.

When found, the stomach is seized with pronged forceps, and drawn up into the abdominal wound. At this stage, Verneuil secured the stomach by transfixing its wall with two long acupressure needles crossing the cutaneous wound at right angles, incised it, and fastened the edges of the two incisions together with fourteen silver sutures. Labbé, before opening the stomach, fastened it to the abdominal wall by eight silver sutures passed by means of sharply curved needles, which were made to transfix the abdominal wall nearly half an inch from the edges of the incision. By this means the two peritoneal surfaces, visceral and parietal, adjoining the incisions were maintained in contact, and their immediate union favored.

Peritonitis threatened in Labbé's case, but was checked by the application of a thick layer of collodion over the entire abdomen, immobilizing the latter so completely that the respiration became purely supra-costal.

The method now in favor in gastrostomy is to stitch the parietal peritoneum to the skin all around the incision, and then to fasten the unopened stomach in the wound by several sutures which traverse its muscular coat but do not enter its cavity, and whose deeper ends then transfix the abdominal wall. This gives a broad surface of contact between the peritoneum of the stomach and that of the abdominal wall, and favors their prompt union. The protruding portion of the stomach may also be transfixed with two long pins which rest upon the skin and prevent strain on the sutures. The opening of the stomach is delayed as long as possible, from one to eight days. If necessary, food can be introduced by punoturing with an aspirating needle.

LAPAROTOMY, ABDOMINAL SECTION (GASTROTOMY).

Laparotomy may be undertaken for the relief of occlusion of the intestines, or, as in the case reported by Dr. Samuel

White, of Hudson, N. Y., in 1806,[1] for the removal of a foreign body from the small intestine or as a part of operations upon the contents of the abdomen. When the nature and seat of the obstruction can be determined beforehand, and especially in cases of intussusception, as Dr. Sands has shown,[2] the operation, if not too long delayed, offers a reasonable chance of success; but in chronic invagination, and when, the cause and position of the obstruction being unknown, the chances of finding it, or of relieving it when found, are very slight, and the dangers of laparotomy very great, Nélaton's operation of enterotomy should be preferred. An exception to this preference for enterotomy must be noted in those rare cases where the obstruction is situated very high up, probably near the duodenum; for then the portion of intestine above the obstruction will not be able to absorb sufficient food, even if it is long enough to permit of the establishment of an artificial anus in the groin. In such a case any surgical interference must be directed to the immediate removal of the obstruction.

Operation.—The point for making the incision may sometimes be determined by the position of the obstruction or the foreign body, but in most cases it should be made in the median line below the umbilicus. After having recognized the peritoneum and divided it upon a director, a finger should be introduced, and the obstruction sought for. In the case of an intussusception, the invaginated portion should be gently withdrawn; if any difficulty is experienced in accomplishing this, the loop should, if possible, be brought out through the incision, and disinvagination effected by pulling the outer or ensheathing layer downward, and squeezing back the lower end of the intussusceptum. If the invagination cannot be reduced, or if it is found to be gangrenous, it has been proposed to excise it, and unite the divided ends of the intestine by sutures, or to insert the upper end into the cæcum, and close the lower end with a ligature. Leichtenstern[3] has collected three cases of the latter operation, only one of which was successful.

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[1] Republished in *Amer. Journ. of Med. Sciences*, July, 1876, p. 279.

[2] In a valuable paper upon The Treatment of Intussusception by Abdominal Section, *N. Y. Med. Journ.*, June, 1877.

[3] Ziemssen's Cyclopædia, New York, vol. vii. p. 662.

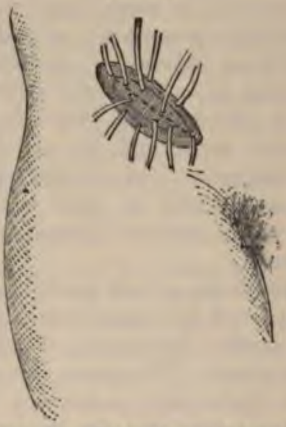
RIGHT INGUINAL ENTEROTOMY (NÉLATON'S OPERATION).

As long ago as 1819, it was proposed to establish an artificial anus in the ileum in case the intestinal obstruction could not be found or removed by laparotomy; but Nélaton was the first (1840) to substitute this for the other operation, giving up the search after the obstruction entirely. His theory was that many obstructions would relieve themselves in time, if a temporary outlet should be furnished to the accumulation above; in some cases, on the other hand, where the obstruction is permanent, an artificial anus in the ileum meets the "vital indication" perfectly—for example, when the obstruction is in the lower portion of the small intestine; while in others, again, where the occlusion occurs below the ileo-cæcal valve, and the relief afforded would, consequently, be imperfect, the obstruction is usually due to malignant disease, which in itself would soon destroy life, and against which neither laparotomy nor any other operation would avail.

It is also essential to the proper nourishment of the patient that the greater part of the small intestine should remain serviceable; that is, that the opening should be made in the lower part of the ileum. Of course, this cannot be accomplished when the obstruction is situated high up, but, in other cases, Nélaton found that the intestinal loops nearest the obstruction always occupied the right iliac fossa, and he, therefore, cut through the abdominal wall just above the outer half of Poupart's ligament on the right side, and opened the first loop that presented in the incision. The portion of the intestine below an obstruction is always empty and shrunken, and does not come into contact with the anterior abdominal wall, so that there is no danger of making the opening in it by mistake. It occasionally happens when the obstruction is situated in the colon, that the distended cæcum fortunately presents in the incision, and the artificial anus is established below the ileo-cæcal valve.

The operation is simple (Fig. 207). Make an incision parallel to and about an inch above Poupart's ligament, beginning at the anterior superior spine of the ilium, and ending opposite the internal inguinal ring. Divide the tissues layer by layer, open the peritoneum upon a director for one and one-half inches, and fasten the intestinal loop which presents in the opening to the abdominal wall, first by a wire suture at each end of the incision, and then by two or three others on each side. Open the intestine by a longitudinal incision between the two rows of sutures. The sutures should not include the skin, and are best placed by means of a sharply curved needle, which is first passed into the intestine, and then brought out through it and the deep edge of the incision. By this means the peritoneal surfaces are kept so closely in contact, that when the intestine is opened its contents cannot make their way into the peritoneal cavity. Or the parietal peritoneum may first be drawn out and stitched to the skin, as recommended in gastrostomy, *q. v.*

FIG. 207.



Right inguinal enterotomy. Nélaton.

For description of the operation by which the continuity of the intestine may be restored in cases in which the occlusion is ultimately relieved, see Closure of Artificial Anus, p. 348.

COLOTOMY.

The colon may be opened in its ascending or descending portions by an incision in the lumbar region not involving the peritoneum, or at the sigmoid flexure by an incision in the left inguinal region opening the peritoneal cavity. The latter is known as Littre's operation or inguinal colotomy, the former as Callisen's or Amussat's, or as lumbar colotomy. Littre's operation, for a long time almost entirely superseded by the other, except in cases of imperforate anus, should, I think, be generally preferred to it because of its greater ease and certainty of execution, and equal, if not greater, safety. The dread of opening the peritoneal cavity, which led to the invention of lumbar colotomy, and gave it its vogue, has been greatly diminished by antiseptic methods.

Littre's Colotomy, Inguinal Colotomy.—Huguier asserted that the sigmoid flexure in infants is very long, and is to be usually found in the right iliac region, but more recent investigations have shown this position to be an infrequent abnormality; consequently the intestine must still be sought for on the left side, as Littre recommended. An incision, one inch in length, is made parallel to and a little above the outer half of Poupart's ligament, and the tissues, including the peritoneum, divided layer by layer. The sigmoid flexure, which can be recognized by its irregular lobulated surface and its fringe of fat, is then sought for, drawn into the wound, fastened to its edges, and opened in the manner described under *Right Inguinal Enterotomy.*

In the adult the incision should be from two to three inches long. The sigmoid flexure can be readily secured by passing the finger through the incision along, and constantly in contact with, the iliac fossa, the peritoneal lining of which is reflected to form the mesocolon. When the finger reaches the intestine it should be hooked over it, and can then easily draw it forward. Ordinarily the flexure presents spontaneously in the incision.

If the need is not pressing, the opening of the intestine may be deferred for a few days.

Lumbar Colotomy.—This operation was first suggested by Callisen,[1] in 1797, as a substitute for Littre's, with a view to avoiding the dangers incidental to an incision through the peritoneum. He proposed to open the descending colon in the posterior third of its periphery, where it is not covered by peritoneum. So far as known, Amussat was the first to perform the operation in 1839, and although he opened the ascending colon, and by a transverse instead of a vertical incision, the operation was essentially the same as that proposed by Callisen. All that portion of the descending colon which lies above the crest of the ilium is usually uncovered by peritoneum on its posterior aspect, and although the actual breadth of the uncovered portion varies with the degree of distention of the bowel, it usually amounts to one-third of the entire circumference, and is bounded on each side by one of the three longitudinal bundles of unstriped muscle characteristic of the colon. In position it corresponds nearly to the outer border of the quadratus lumborum, and very exactly to a vertical line drawn a full half inch behind the centre of a transverse one, uniting the anterior and posterior superior spines of the ilium (Mason). On the right side (ascending colon) the uncovered portion is more often smaller, and the existence of an actual mesocolon, although rare, is yet more frequent than upon the left side.

Callisen proposed a vertical incision a little external to the outer border of the erector spinæ; Amussat made a transverse one midway between the last rib and the crest of the ilium, while Baudens and Bryant used an oblique one passing downward and outward at an angle of 45°. The latter is to be preferred, because, while giving sufficient room, it inflicts less injury upon the vessels and nerves of the parts, the general direction of which is the same as that of the incision.

The operation is performed as follows: The patient is etherized, and placed in a position midway between the prone and right lateral, a hard cushion being placed under the left side of the abdomen to raise and support it. Mason[2] says the operation has been performed with the patient seated and leaning forward over the back of another chair, local anæsthesia being obtained by means of the ether spray. The anterior and posterior superior spines of the left ilium are then recognized, and a vertical line drawn upward from a point one-half to three-quarters of an inch behind the centre of a transverse line drawn from one to the other. This vertical line should be marked with iodine or nitrate of silver, in order to serve as a guide during the operation.

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[1] Erskine Mason, Six Cases of Lumbar Colotomy, *Am. Journ. of Med. Sciences*, Oct. 1873.

[2] Loc. cit.

If the occlusion of the intestine has not been complete, and there is reason to suppose that the colon will be found empty, it may now be distended by injecting air or water through the rectum. Mason prefers air, and gives good reasons for the preference.

A transverse or an oblique incision four or five inches long is then made, its centre lying in the vertical line above mentioned midway between the last rib and the ilium. The underlying tissues are recognized and divided layer by layer, until the fascia transversalis and quadratus lumborum are reached. The former is next carefully divided, and, if the adipose tissue covering the colon does not then appear in the wound, the latter should be enlarged on the inner side by dividing the outer fibres of the quadratus. The intestine must always be sought for in the angle of the wound nearest the spine, and whenever it is desired to increase its exposed area this must be done in the same direction. Bleeding should be arrested as it occurs, certainly before the intestine is opened.

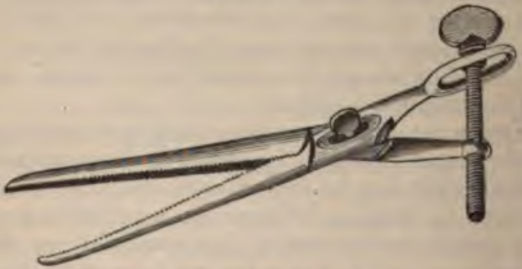
The colon can usually be recognized by its distention and greenish hue, and possibly by one of its longitudinal bands. Additional light may be thrown upon the correctness of the recognition by noticing whether the supposed colon corresponds exactly to the vertical line marked upon the skin, and whether or not it moves up and down with the acts of inspiration and expiration, for while the small intestine has this motion the lumbar colon has it not.

Two stout ligatures are next passed by means of curved needles through the presenting portion of intestine, and used to draw it up into the wound, and fasten it to the skin at the sides of the incision. The wound is then filled with sponges or lint, and the bowel opened by a longitudinal or crucial incision. As soon as the discharge has ceased, the sponges or lint are withdrawn, the parts cleaned, the extremities of the tegumentary wound closed with silver sutures, and the edges of the opening in the intestine made fast to the skin with a few sutures of fine silk.

CLOSURE OF AN ARTIFICIAL ANUS OR FECAL FISTULA.

When the opening into the intestine is small and the communication between the portions of the canal lying above and below it is free, the fistula will ordinarily close spontaneously, or after one or two applications of a caustic or cautery. But when the opening is larger, the remaining portion of the wall of the intestine is pressed forward into it, and forms a sort of valve or spur which prevents, more or less completely, the descending current of feces from entering the lower segment of the bowel, and turns it out through the opening on the surface. This spur must, therefore, be removed before an attempt to close the external orifice is made. This is best accomplished by means of Dupuytren's enterotome (Fig. 208), or some similar instrument, which by steady pressure upon the spur provokes adhesion between its opposing peritoneal surfaces, and cuts through it in four or five days.

Fig. 208.



Dupuytren's enterotome.

After the channel has been reëstablished, the external orifice may be closed. If paring of the edges and approximation by sutures do not suffice, more elaborate plastic methods must be employed. The fistulous tract between the intestine and the skin is lined in most cases with mucous membrane, which must be dissected up almost to the peritoneum, turned inward, and its raw surfaces united with sutures. Liberating incisions are then made through the skin and tendon of the external oblique (if the fistula is in the groin), the sides of the opening pared still further if necessary, and brought together. Or lateral flaps left adherent at both ends (*lambeaux en pont*) may be dissected up, and their sides united to each other along the centre of the opening.

It sometimes happens that the lower portion of the intestine does not communicate with the fistula, and cannot be found. If the upper portion is too short for the proper nourishment of the patient, or if he is determined to be rid of his infirmity at any risk, it may be justifiable to seek for the lower end, and, by attaching it to the opening beside the upper end, make it possible ultimately to restore the continuity of the canal, and close the fistula as above described.

In a case where the fecal fistula occupied the right groin, Maisonneuve exposed the cæcum by an incision parallel to Poupart's ligament, and one inch above it, and established communication between it and a loop of intestine situated just above the fistula, by making a longitudinal incision, two inches long, in each, and suturing their edges together with the peritoneal surfaces in contact. The patient did not survive the operation.

In a similar case Laugier cut down upon the cæcum, stitched it fast to the edges of the cutaneous incision, and then, by means of a specially designed enterotome, which was kept applied for seven days, established communication between it and the small intestine. The patient died shortly afterward, before the fistula had been obliterated, but the method is certainly much better than Maisonneuve's.

SUTURE OF THE INTESTINES.

Of the great variety of methods which have been proposed for closing wounds of the intestines, only those deserve mention which are based upon the principle laid down by Jobert of uniting surfaces covered by peritoneum. The mucous membrane is so freely movable upon the muscular coat that some surgeons think wounds less than one-quarter of an inch in length may be safely disregarded, because the lack of correspondence between the two openings will prevent the escape of the contents of the intestine, and the wound will close spontaneously. Prof. Gross,[1] however, maintains that any wound, no matter how small, is likely to be followed by escape of feces into the cavity of the peritoneum. On the other hand, when the wound is so large, or of such a character, that the surgeon is unwilling to trust to a suture, it must be attached to the abdominal wall, as in enterotomy, and an artificial anus created, which, if it does not close spontaneously, may be afterward closed by the surgeon. Wounds of intermediate sizes must be closed either by fastening them against the abdominal wall so that communication between the interior of the canal and the abdominal cavity will be closed by adhesion between the visceral and parietal surfaces of the peritoneum, or by turning the edges of the wound inward and fastening them together with sutures. It is usual to classify the methods according to their applicability to longitudinal or transverse wounds, although some of them may be used for either.

Longitudinal Wounds.—When the wound is small it may be fixed against the inner edges of the abdominal wall by a suture passed through the centre of its two sides, brought out through the abdominal wound, and fastened to the skin by adhesive plaster.

Reybard kept the edges of the wound in contact with each other and with the abdominal wall by means of a small oval piece of wood, traversed by a ligature at two points on its transverse axis, so that the loop of the ligature lay upon one side and its two ends upon the other. The piece of wood is placed within the intestine, its long axis corresponding to the wound, and the ends of the ligature brought through the intestine at a short distance on each side of the solution of continuity, and then by a single needle through the abdominal wall near the external incision. The ends of the ligature are then separated, drawn tight, and tied over a roll of lint. After three or four days the ligature is cut and withdrawn, and the piece of wood is passed with the feces.

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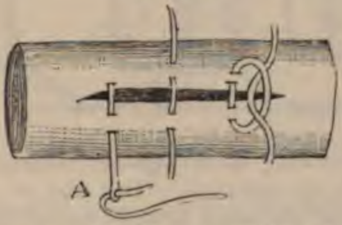
[1] Am. Jour. of Med. Sciences, April, 1876.

Jobert used the simple interrupted suture, taking the precaution, however, to roll the edges of the wound inward so as to bring the peritoneal surfaces in contact. He sometimes cut the ends short, and sometimes brought them out through the abdominal wound. In a former case they ultimately fell into the intestine; in the latter, they were withdrawn on the fifth or sixth day.

Lembert modified this by making the ligatures include only a narrow strip of the muscular and none of the mucous coat (Fig. 209). A needle carrying the ligature was entered on the outer surface of the intestine four millimetres from the edge of the wound, and brought out two millimetres from it without having perforated the mucous membrane. It was then passed in the same manner on the opposite side, and after the necessary number of ligatures had been thus inserted they were tied and cut short. The effect of this method of placing the ligutures is to roll the edges of the incision inward and to avoid the danger of an escape of feces into the abdominal cavity through an opening left by the fall of a ligature. The ligatures should be of silver, carbolized silk, or tough catgut.

FIG. 209.

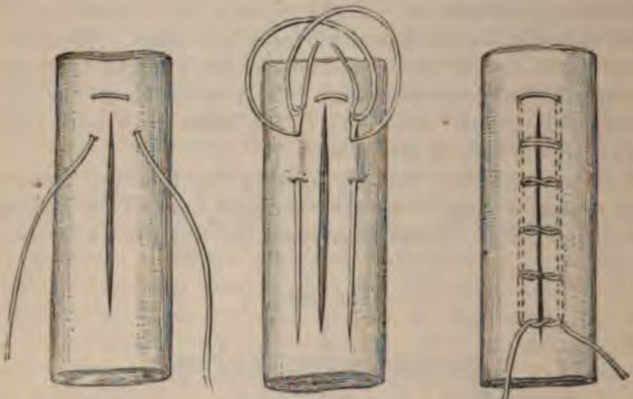


Suture of the intestines. Lembert's method.

Gély used a long ligature with a needle at each end, and placed it as shown in Fig. 210. The points of entry should be about five millimetres apart. The needles used should be small, and it is well to make a knot at each crossing.

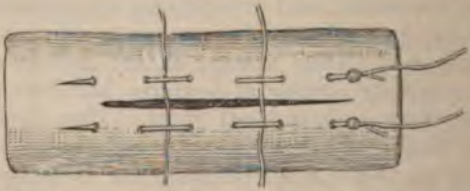
Bouisson obtained the same result by passing an insect pin in and out along each side of the wound, as shown in Fig. 211, and drawing them together laterally by ligatures passed through the intervals. One end of each ligature was cut short, and the other brought out at the lower angle of the external wound; a thread was tied under the head of each pin and brought out at the upper angle of the wound. On the third or fourth day the pins were withdrawn by means of the threads attached to them, and the

Fig. 210.



Suture of the intestines. Gély's method.

Fig. 211.

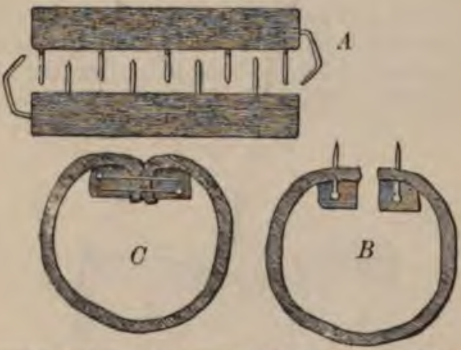


Suture of the intestines. Bouisson's method.

ligatures having been thus freed, were withdrawn at the same time.

Bérenger-Féraud used two strips of cork six millimetres wide and thick, and as long as the wound (Fig. 212, *A*). Each piece is pierced by pins whose points project five or six millimetres on one side, and whose heads are sunk in the cork and covered with sealing-wax on the other. They are then placed inside the intestine, one on each side of the wound and parallel to it, and the pins forced through from within outward two or three millimetres from the edge (Fig. 212, *B*). They are then turned so that the points face each other, and the pins of each driven into the other by pressure through the sides of the intestine. The strips ultimately come away with the feces.

Fig. 212.



Bérenger-Féraud's method of closing a wound of the intestine. *A*. The strips. *B*. The strips in place. *C*. The strips pinned together and the opening closed.

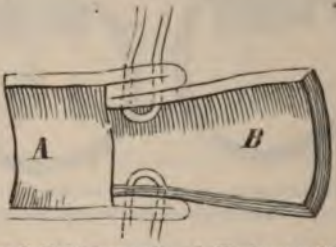
Dubrueil suggests that the strips should be fixed together more firmly by a bent pin at each end, as represented in the figure; there would then be less danger of their falling apart and injuring the intestine on their way out.

These methods have given place to antiseptic silk or catgut sutures applied according to Lembert's method and cut short.

Transverse Wounds.—The old methods of uniting a divided intestine end to end over a cylinder of cardboard or a calf's trachea introduced within it, or of simply inserting the upper end into the lower, have fallen into entire disuse. The safest plan in most cases is to make an artificial anus and trust to closing it afterward, but when that is not practicable, or when the wound is small, it may be closed by any of the methods above described, modified according to circumstances. Holmes[1] says it is entirely justifiable, even in cases of total division, to unite the edges with the continuous suture, cut it short, and let it ulcerate through into the bowel.

Jobert turned the lower end of the bowel in upon itself, and then introduced the upper one, fastening them together with two ligatures which he brought out at the abdominal wound (Fig. 213). When the division was incomplete, he used only one ligature. The principle of this method is correct, for it brings two peritoneal surfaces into contact, but it may be difficult to determine which is the lower and which the upper end. The best means is to pass the finger backward along the mesentery to its posterior attachment which, being fixed, is a sure guide.

FIG. 213.



Reunion of intestines divided transversely. *A.* The lower end doubled inward upon itself. Jobert's method.

HERNIOTOMY, KELOTOMY.

Under this head are to be described the operations for the relief of strangulated *inguinal*, *femoral*, *umbilical*, and

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[1] Surgery, its Principles and Practice, p. 237, Philada., 1876.

obturator hernias, and those for the radical cure of the first three varieties.

It has been well said that there is no operation in which the unforeseen has a larger share than in herniotomy, none in which the surgeon is called upon to show more skill, sagacity, and decision. The causes of this are to be found in the absence of absolute guides to the hernial sac, the changes in the sac and overlying tissues brought about by inflammation or time, the character of the hernia—whether composed of omentum, intestine, cæcum, or bladder, and lastly, the difficulty of determining not only the extent of the injury done to the strangulated tissues, but even, in some cases, the route taken by the hernia in its descent. It is desirable, therefore, that the account of the different operations should be preceded by some general considerations upon these subjects.

General Directions. A. *Recognition of the Sac and Bowel.*—The first difficulty encountered in the course of the operation is that of recognizing the sac. The thickness of the connective tissue covering it varies greatly in different cases; each layer must be pinched up with forceps, opened with the knife lying upon its side, as in opening the sheath of an artery, then raised upon the finger or a director, and divided to the full extent of the cutaneous incision, after having been carefully scrutinized. Occasionally a cyst containing liquid is found in front of the hernia, and may at first be mistaken for it, for usually the sac contains a certain amount of serum. Careful examination of the tissues before division is absolutely necessary, because in those rare cases where there is no sac (hernia of the cæcum or of the bladder), and in others where it is quite undistinguishable, it is only by recognizing the muscular coat when he reaches it, that the surgeon avoids opening the intestine or bladder by mistake. As the sac is approached, each layer should be pinched up in a narrow fold, and moved gently across the underlying parts; if a smooth globular tumor is felt below, the surgeon makes an opening in the fold, confident that the wall of the intestine is not included in it; but if he is unable to pinch up the fold, or if, instead of the sensation of a smooth globular mass, he gets only that of an empty space, he examines the surface again, divides with a probe-pointed bistoury any fibrous bands he may find at the neck of the hernia, and tries to introduce his finger through it into the abdominal cavity. If he succeeds, he knows the sac has been opened; if he does not succeed, he renews the examination and continues the dissection.

Maisonneuve said the surgeon may know he has not reached the intestine so long as he is not certain of having done so; but this is not true of all cases; the intestine is not always smooth and shining; it may be dark, dull, congested, and thickened, and in hernia of the cæcum it may have no peritoneal coat.

When the hernia is small and recent the sac is bluish, and can be pinched up between the thumb and finger, so that its smooth opposing surfaces can be felt to glide upon one another. When it is large and of long standing, the sac may be exceedingly thin and unrecognizable, or very thick and adherent. If small, it should be thoroughly isolated, and its boundaries everywhere defined; if large and adherent, its neck alone should be cleared.

B. *Opening of the Sac.*—The propriety of opening the sac has long been a subject of dispute. The only objection to it, but that a serious one, is the danger of thereby setting up peritonitis. On the other side is the danger of returning the hernia into the abdomen in a gangrenous condition, or unreduced when the stricture is formed by the sac itself. Admitting that the opening of the sac is in itself an evil, and, therefore, to be avoided whenever possible, two general rules may be laid down. The sac should be opened: 1st. Whenever there is good reason to fear that the bowel is gangrenous, when there has been long-continued vomiting and tenderness on pressure; and 2d. Whenever the hernia cannot be completely returned into the abdomen. In estimating the chances of gangrene, it must be remembered that it occurs much more promptly after the symptoms of strangulation appear in sudden recent hernias, than it does in old ones.

The liquid which, as has been already mentioned, is usually contained in the sac, may not only serve to call attention to its accidental opening, but may also be taken advantage of to open it safely when it has been recognized, and its opening has been determined upon. It, of course, collects at the most dependent point, and there intervenes between the sac and the bowel, so that the former can be pinched up and opened without injury to the latter. When this is not the case, the surgeon must pinch up a very small fold of the sac wherever he can do so, or do as Mr. Liston did in a case where, as he says, "there was no possibility of pinching up the sac, either with the finger or forceps; it contained no fluid, and was impacted most firmly with bowel; very luckily the membrane was there; and, observing a pelleton of fat underneath, I scratched very cautiously with the point of the knife in the unsupported hand, until a trifling puncture was made, sufficient to admit the blunt point of a narrow bistoury."[1] The opening should be enlarged until the finger can be introduced, and then the sac slit up on it as a guide. If the omentum is then found filling the sac, it must be cautiously cut into, for it is probable, especially in umbilical hernia, that a strangulated loop of intestine will be found in its centre. If such a loop is found, the finger must be passed along the bowel, the director inserted below the ring of the omentum, and the constriction incised just sufficiently to admit of the return of the bowel.

C. *Division of the Stricture.*—The left forefinger is passed up into the neck of the sac to the stricture, the pulp upward, the nail pressing against the intestines; if the stricture is found to be caused by a fibrous band below the neck of the sac, it may be divided freely without risk; but if it is situated at the opening in the abdominal wall through which the hernia made its escape, the division must be made with reference to the anatomy of the region. If the division cannot be made at the desired point, but only at some other where an incision of the necessary extent would be dangerous, the stricture must be slightly nicked at that point, and advantage then taken of the partial liberation to make a second cut in the proper place.

The end of the finger, or its nail, is gently engaged in the stricture, its pulp against the selected point of division, and the knife, a probe-pointed, slightly curved bistoury, passed on the flat along its palmar surface until the point has passed through the stricture. The surgeon then turns its edge upward and presses it against the stricture with the end of the finger on which it rests. A slight crackling announces the division, which must be extended or repeated at different points until the finger can be passed freely through into the abdomen.

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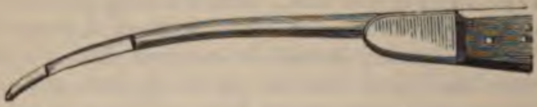
[1] Op. Surgery, p. 462, quoted by Jos. Bell, Manual of Surgical Operations, p. 231.

Instead of an ordinary probe-pointed bistoury, a specially constructed hernia knife (Fig. 214) is often used. It is probe-pointed and its cutting edge not more than an inch long. The knife may also be guided upon a director instead of the finger. The "hernia director" is broader than the ordinary one, and sometimes has a broad flange on each side to keep the bowel from rolling over against the edge of the knife.

FIG. 214.



Hernia knife.

D. *Examination and Return of the Bowel.*—The bowel should be gently drawn out about an inch in order that the constricted part itself may be examined, for it is very likely to be badly damaged. If the entire loop is in suitable condition it must be carefully cleaned of all blood and gradually returned into the cavity of the abdomen. It is not always easy to decide, however, whether or not its condition is suitable for return, and some surgeons have recommended that in cases of doubt it should be covered with warm, wet cloths and kept under observation for some time, the stricture, of course, having been previously divided.

A very great change in the color of the loop is far from proving the existence of gangrene. A deep red, vinous, even violet color does not preclude recovery, especially if the surface has not lost its lustre; but if it is black, or deep brown, or grayish-yellow, or if it is dull, flaccid, or wrinkled, it is certainly gangrenous. Of course, when the characteristic gangrenous odor, or the fecal odor consequent on perforation, exists, there can be no doubt.

If the loops are in good condition, but bound fast to one another, or to the omentum, or to the sac by firm adhesions, great caution must be exercised in dealing with them. The stricture must be freely divided and the loops emptied of their contents by pressure; but the adhesions, which have probably existed for a long time without inconvenience to the patient, should in most cases be left undisturbed, the wound closed, and the hernia treated as an irreducible one.

It is not always easy to return the intestines even after the stricture has been divided. The surgeon should try to reduce one end at a time, by squeezing its contents back into the abdomen and pushing the gut in afterward. If the bowel is very tense the gas may be drawn off with a fine aspirator. If rupture occurs, and the bowel is otherwise in good condition, it must be closed with the continuous suture (Holmes) and returned into the abdomen.

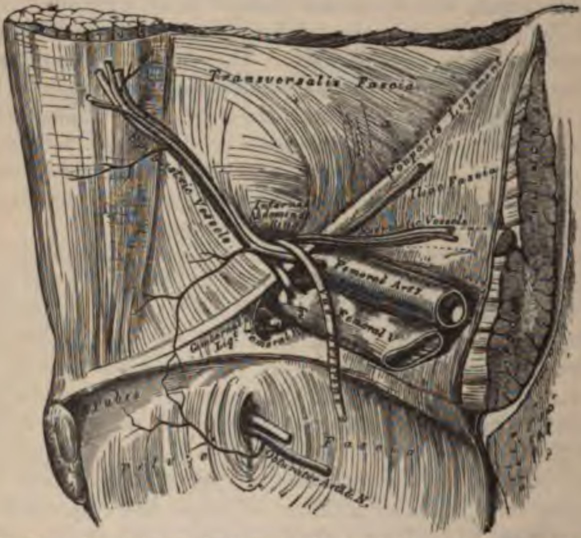
If the intestine is gangrenous, an artificial anus must be formed, and it is well to stitch the bowel fast to the edges of the hernial ring, as in enterotomy. If the gangrene extends to the point of stricture and the bowel cannot be drawn further out, the stricture must not be divided, lest the bowel should slip back and feces escape into the peritoneal cavity. The gangrenous portion must be incised, and then, if the feces pass freely, nothing more need be done, beyond taking measures to prevent the bowel from slipping back, such as making its edges fast to the sides of the incision, or passing a stout ligature through the mesentery and fastening it to the skin with adhesive plaster. But if the stricture still prevents the flow of feces, Gosselin's plan of dilating it by introducing the finger into the intestine should be adopted.

E. *Treatment of the Omentum.*—If only a small amount of omentum is found in the sac, and if it is in good condition, it may be returned; but if there is much of it, or if it is inflamed, suppurating, or gangrenous, it must be kept out. Holmes says the practice at St. George's Hospital is to transfix its base with a stout double ligature and cut it off, bringing the ends of the ligature out through the wound;

some excise it and tie all bleeding points, while others again simply leave it in the wound.

Strangulated Inguinal Hernia.—Inguinal hernia may be *oblique* or *direct.* The former leaves the abdomen at the internal (deep) abdominal ring, having the deep epigastric artery on its inner side (Fig. 215), passes down the inguinal canal, and emerges at the external abdominal ring (Fig. 216); the latter makes its way through Hesselbach's triangle, a space bounded by the epigastric artery, Poupart's ligament, and the rectus abdominis muscle (Fig. 215), and also emerges at the external abdominal ring. The former is by far the more common variety, and the seat of stricture is usually at the internal abdominal ring, but sometimes in the scrotum, at a point where the intestine has forced its way through a fibrous septum limiting an encysted hydrocele of the cord. In the second variety the

FIG. 215.

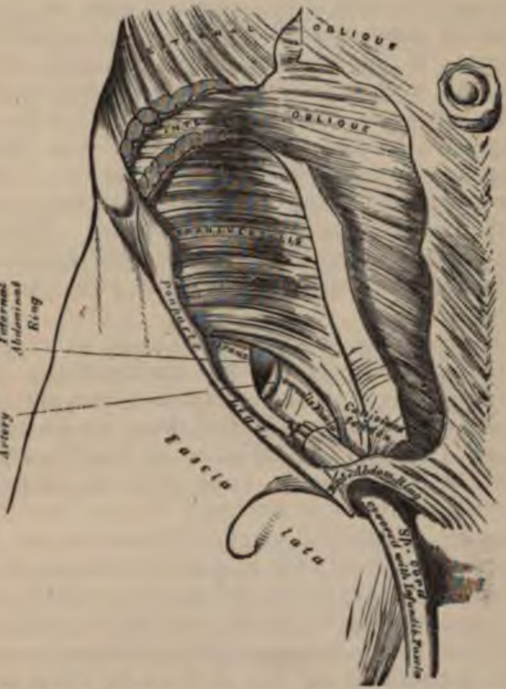


Hernia. The relations of the femoral and internal abdominal rings, seen from within the abdomen Right side.

stricture may be at the external ring or at the conjoined tendon, the epigastric artery lying at its outer side.

Operation.—The parts having been well shaved, the patient is anæsthetized and placed upon his back, with his shoulders slightly raised, thighs flexed and adducted. The surgeon pinches up a broad fold of skin and subcutaneous tissue across the long axis of the swelling, transfixes it at its base with a straight bistoury, and cuts vertically through it, thus dividing most of the tissues without danger of injury to the sac or intestine; if necessary, this incision must be lengthened, so that its upper extremity will lie at or above the external abdominal ring, and its lower extremity below

FIG. 216.



Inguinal hernia, showing the transversalis muscle, the transversalis fascia, and the internal abdominal ring.

the bottom of the hernial sac. The underlying layers are then pinched up one by one with the thumb and finger, or with fine forceps, and divided upon a director until the sac is reached.

If the sac is recognized, and if it is thought best not to open it, its limits must be well cleared and defined, unless it is very large, and the finger passed into the external abdominal ring. If the ring is tight, the internal pillar must be divided directly upward with a probe-pointed knife, all constricting bands about the neck of the sac raised upon the director and cut, and the canal and internal ring explored with the left forefinger. If the stricture, which is usually situated at the internal ring, is then found to be external to the sac, it must be cautiously nicked directly upward with a narrow probe-pointed bistoury or a hernia knife (Fig. 214). This nicking may be repeated, if necessary, at one or two points on the upper and outer side, until it becomes possible to press the intestines back into the abdomen. The sac itself is then reduced, unless the hernia is an old one, or adhesions have formed, and the wound is closed with sutures except at its lower angle.

If, however, the sac is to be opened, every precaution must be taken to avoid injury to the intestines. The best point for opening it is at its extreme lower end, because a little serum is usually collected there, separating it from the bowel. It must be pinched up, if possible, at the point selected, and an opening made with the knife held flat against it; a director or the finger is then passed through the opening, and the full length of the sac slit up. The constriction is then sought for, and, if found above the external ring, must be nicked or divided upward, as before described.

If it can be positively made out that the hernia is of the *oblique* variety, the cutting should be done on the outer side, for the epigastric artery lies close to the inner side of the internal ring, through which this variety passes; and if it is known to be of the *direct* variety, the cutting must be done upon the inner side. But, unfortunately, in most cases the dragging of the hernia brings the two rings immediately opposite each other, so that the inguinal canal can no longer be said to exist, and the diagnosis cannot be made with certainty. The incision must then be made upward, parallel to the course of the epigastric artery.

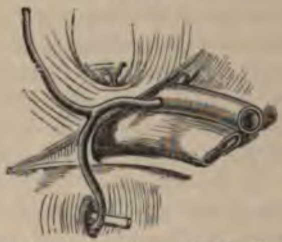
The intestine must next be examined to ascertain if it is in a fit condition to be returned; and here it must not be forgotten to draw down an inch or more of each end so that the part which has undergone constriction may also be examined. If the condition is satisfactory, the bowel is returned gradually, not *en masse*, the sac also, if free; and the wound closed, except at the dependent angle.

Malgaigne's Method.—Malgaigne made a small incision directly over the supposed seat of the stricture, and divided all the tissues down to the sac. If a fibrous ring was the cause of the strangulation, it would be divided in the course of the incision, and the hernia could then be reduced without opening the sac. If, on the other hand, the stricture was caused by the neck of the sac, he divided the latter from without inward very cautiously, or, if it was very tight, made a small opening in the peritoneum above and below, passed a director through the neck, and cut upon it.

This method is entirely inapplicable whenever it is necessary to examine into the condition of the bowel; and the persistence of a pouch in which pus can accumulate is a great objection whenever the sac has to be opened. The only advantage which it possesses over the ordinary operation in the class of rarer cases where the stricture is situated outside of the sac is the comparatively unimportant one of requiring a smaller incision.

Strangulated Femoral Hernia.—The intestine in its descent occupies a canal which begins at the femoral ring under Poupart's ligament, between the free arched border of Gimbernat's ligament, and the femoral vessels (Fig. 215), and ends at the saphenous opening in the fascia lata of the thigh. After passing through the opening it turns upward over the groin. The normal length of the canal is about an inch, but in hernias of long standing it is much shortened by the approximation of its two ends. The seat of stricture is now thought to lie in most cases at the saphenous opening, and not at the base of Gimbernat's ligament, as was formerly supposed; free division is possible at the former point on the upper and inner side without the risk of injury to any organ, except possibly the spermatic cord, and that is at such a distance as to be practically out of harm's way. Under ordinary circumstances, Gimbernat's ligament can also be safely divided on the inner side, but in about one and one-half per cent. of cases the obturator artery pursues the anomalous course shown in Fig. 217, and then lies directly in the way of the knife. The neck of the sac under such circumstances is entirely surrounded; on its outer side are femoral vessels, above are the spermatic cord and common trunk of the epigastric and obturator arteries, on its inner side the obturator artery, below it the bone. The only safe plan of relieving the stricture, therefore, is to nick it slightly, to the depth of one or two millimetres, at several points on its upper and inner borders. The coverings of the hernia are thin and composed of the skin, subcutaneous tissue, cribriform fascia sometimes, septum crurale, and peritoneum.

FIG. 217.



Variations in origin and course of obturator artery.

The incision may be straight or curved, the convexity directed downward and outward, or T-shaped, the horizontal branch being made along Poupart's ligament, the other passing directly downward over the saphenous opening. The horizontal incision should be made by transfixing a vertical fold of skin and subcutaneous tissue pinched up between the thumb and fingers, the other should be made from without inward. The underlying tissues must be divided, and the sac exposed or opened in the manner described under *General Directions*, and the seat of stricture sought for and divided according to the rules above laid down. If the operator has decided to perform the so-called *minor operation*—that is, not to open the sac—the edge of the saphenous opening must be carefully exposed and divided on its upper and inner side, the finger passed into the canal, and Gimbernat's ligament nicked if necessary.

Malgaigne pursued the same method as in femoral hernia, cutting down upon the seat of the stricture, tearing the edge of the saphenous opening with a blunt spatula instead of cutting it, and not opening the sac unless he had good reason to suppose the intestine was already damaged. It is particularly unsafe to reduce a femoral hernia unopened; first, because the boundaries of the canal are so tough and unyielding that gangrene follows promptly on strangulation, especially in a small recent hernia; and secondly, because the reduction may seem to be complete while a strangulated knuckle of intestine still remains within the stricture.

Strangulated Umbilical Hernia.—It is generally claimed that true umbilical hernia, that is, hernia through the umbilical ring, is almost always congenital, and that the hernias which occur during adult life emerge, not through the ring, but through an accidental opening in the linea alba near it, and therefore deserve the name of *peri-umbilical* given them by Gosselin. While this condition, that is, of escape through a chance opening in the linea alba, may exist in some cases, Richet[1] has sought to prove by anatomical considerations and by the results of the examination of three cases of hernia, that true umbilical hernia, on the contrary, is the rule, and the other is the exception. He shows that the weak point of the ring is its upper portion, and that when the cicatrix is pressed downward and given a semicircular form by the hernia, a complete ring, which seems to be situated above that corresponding to the vein and arteries, is constituted by the cicatrix below and the upper part of the opening above, and exactly resembles a distended accidental perforation.

The peritoneum is much more adherent to the abdominal wall in the umbilical than it is in the inguinal region, and, consequently, the sac of a hernia, being formed by the distention of a small portion of peritoneum, is exceedingly thin, in fact its existence has been denied. The coverings of the hernia are the skin, cellular tissue, and peritoneum; its contents are the small intestine, sometimes the transverse colon, and in the adult the omentum.

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[1] Anatomie Médico-Chirurgicale, Part II. p. 378.

The results of kelotomy in umbilical hernia have been so unfavorable that Huguier proposed the operation should be restricted to recent, small hernias which were previously reducible, and that all others should be left entirely to themselves, or that at the most an incision should be made to facilitate the escape of the fecal contents. This proposal did not receive the sanction of the Société de Chirurgie, before which it was made, and the practice now is to relieve the constriction even when it is not considered safe to return the bowel. In small hernias the sac must be freely opened if the strangulation has lasted for any length of time; in the larger ones the stricture may be divided, if possible, outside the sac or through a small opening made in the sac near the ring. When the hernia seems to be entirely omental the sac must be divided and the omentum torn through and examined, lest it should contain a strangulated knuckle of intestine.

The cutaneous incision may be straight, curved, crucial, or ⊥-shaped; the tissues must be divided very cautiously, for the coverings are thin and the sac adherent. The stricture must be divided at the upper portion and directly upward.

Strangulated Obturator Hernia.—A long incision is made parallel to the femoral vessels and about an inch away from them on the inner side. The pectineus muscle is exposed and divided, as are also any fibres of the obturator externus whose division may be necessary to give access to the seat of the stricture. The relations of the artery and nerve to the neck of the sac must be determined, and the division made in such a direction that they will not be injured.

Radical Cure by Incision and Sutures.—An incision is begun a little above the hernial orifice and carried down along the most prominent part of the swelling for three or four inches; the layers are cautiously divided, and the sac opened a little below its neck, the hernia reduced, the neck of the sac separated from the underlying parts, drawn downward, and tied circularly as high as possible with stout catgut.

If the attempt is made to narrow the orifice by drawing its sides together, this should be done by threading a curved needle on each end of a catgut or silk suture and passing each through one pillar of the ring from within outward, tying, and cutting the ends short. From two to five such sutures are required.

Extirpation of the remainder of the sac is sometimes practised, but is objectionable. The better plan is to divide it transversely below the ligature, tie its upper end circularly, wash it with a strong carbolic acid solution, close the incision over it, and drain it.

If the neck of the sac is so closely adherent that it cannot be isolated and tied, Schede recommends that a drainage tube should be kept in it until granulations have formed which will subsequently close it.

If the hernia is adherent to the sac, incarcerated, it must be separated. Adherent omentum may be ligatured *en masse* and cut off; adherent loops of intestine must be carefully stripped away or the adherent portion of the wall cut away. If bleeding from such loops is anticipated, the canal should be left open and drained.

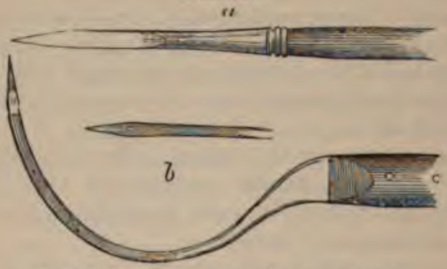
The radical cure without incision has been tried in many ways, but all, with perhaps the exception of Heaton's, seem now to have been quite generally abandoned in favor of the cutting operation. I shall describe only Wood and Heaton's.

Radical Cure of Inguinal Hernia (Wood[1]).—The principle of Mr. Wood's operation is to draw the anterior and posterior borders of the abdominal rings and the sides of the canal together above the spermatic cord, so as to diminish the size of the canal and restore its valve-like action. In his first twenty operations he used a hempen ligature, but he afterward discarded it for a stout silvered copper wire about two feet long. The wire must not be fine, for if it were it would cut through the fibrous aponeuroses and defeat its own object; copper is better than silver because it is less likely to kink and break, and better than iron because more flex-

[1] Wood on Rupture, London, 1863.

ible. The special instruments required are a needle and a knife. The needle is stout, much curved in the shaft, less so near the point, and mounted in a strong handle (Fig. 218). The point is blunt and wedge-shaped, intended not to cut but to split its way through the tendons. The eye of the needle should be smoothly counter-sunk and slightly grooved

FIG. 218.



Wood's knife and needle for radical cure of hernia.

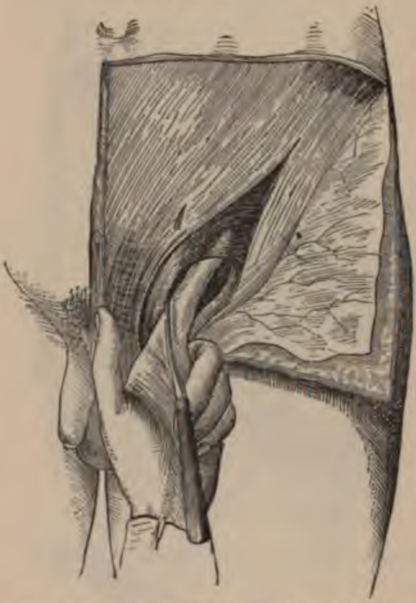
toward the point so as to lodge the wire. The knife is small, the edge cutting only for an inch near the point, the back stout. The end of the handle should be thin, flat, and rounded, so that it can be used to separate the fascia from the skin.

Anæsthesia is essential, and must be carried to complete relaxation; the pubis and scrotum must be shaved; dorsal decubitus, shoulders well raised. The surgeon will find it most convenient to stand on the affected side, and to use for invagination the forefinger of his right hand for the patient's right side, and *vice versâ*. The hernia is first completely reduced, and if there is any tendency to cough an assistant must prevent its return by making pressure over the internal (deep) ring during the preliminary incisions.

An incision from one to two inches long is made downward and outward through the skin of the scrotum, over the fundus of the sac if the rupture is large, and a little below it if small. If the rupture is a bubonocele, confined to the inguinal canal, the incision must be made one and a half inches below the spine of the pubis. The skin about the incision is next separated from the fascia over an area of at least two inches in diameter; usually this can be accomplished with the thin end of the handle of the knife.

Next, the patient's thighs having been brought together and flexed, the surgeon passes his forefinger into the incision, the nail behind, and invaginates the fascia into the canal, beginning low down so as to get the finger as much as possible behind the sac, between its fundus and the spermatic cord. The finger is passed as far as possible into the canal, and the position of the cord and Poupart's ligament distinctly made out; then by hooking its point forward the lower border of the internal oblique muscle will be felt raised upon it (Fig. 219), and may be more distinctly recognized by its greater thickness if the fingers of the other hand are placed over it in the groin. By pressing the finger inward the operator will now feel at its radial side the edge of the

FIG. 219

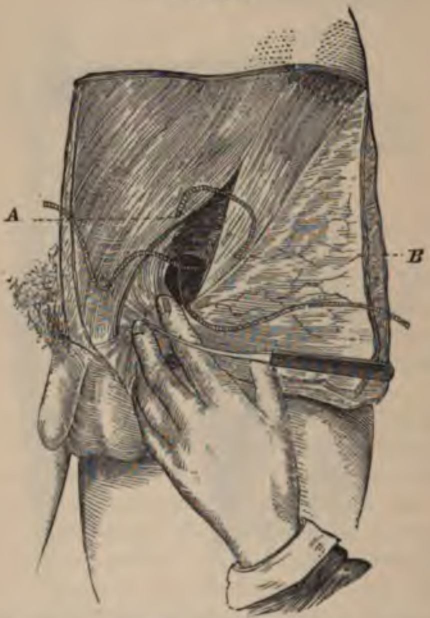


Wood's radical cure of hernia, first puncture. The finger is behind the edge of the internal oblique at the internal ring.

conjoined tendon raised with the muscle and placed in relief on the posterior wall of the canal.

The needle, unarmed and well oiled, is then passed along the same side of the finger, and pushed through the tendon at its most salient part, so as to take up a considerable portion of it (Fig. 219), and then upward and inward, traversing the tendon of the external oblique (internal pillar of the external ring), until its point raises the skin of the groin, which is then drawn inward and a little upward as far as its deep attachments will allow, and the needle passed through it.

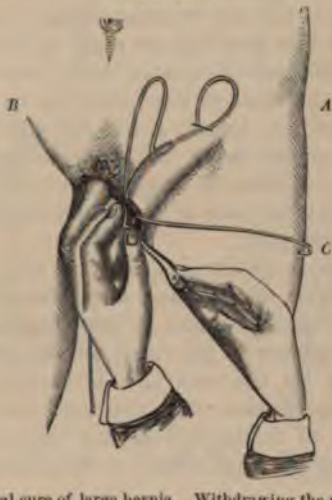
FIG. 220.



Radical cure of hernia. Making the third puncture.

One end of the wire is then passed through the eye of the needle, and the latter withdrawn rapidly, bringing the wire after it. The needle is then disengaged and passed along the other side of the finger as high up as the internal ring, and there passed through the anterior aponeurosis (external pillar), close to Poupart's ligament (Fig. 220, *B*). The skin is then drawn outward, so that the needle can be passed again through the first puncture in it, and, after receiving the other end of the wire, be withdrawn as before. The two ends of the wire now hang out through the scrotal incision, and its centre forms a loop upon the groin (Figs. 220 and 221); one end has traversed the conjoined tendon and internal pillar of the superficial ring, the other Poupart's ligament, or the external pillar of the same ring.

FIG. 221.



Radical cure of large hernia. Withdrawing the needle.
A. The loop. *B*, *C*. The ends of the wire.

The sac of the hernia and the fascia covering it opposite the scrotal incision is then pinched up between the finger and thumb, care being taken not to include the spermatic cord in the fold, but to leave it behind against the bone, and the needle is passed through it in the direction of the incision, picking up all the tissues in front of the cord. The needle should enter and emerge through the scrotal incision, which, if necessary, must be enlarged for this purpose. One of the ends of the wire is then hooked on to the needle (Fig. 221, *B*), and drawn with it across the cord through or behind the sac, traversing the scrotal fascia. Either end of the wire may be taken, but Mr. Wood rather preferred the inner one, that which had been passed through the conjoined tendon, as being better placed to make deep pressure, and more easily withdrawn at the end of the treatment. The outer one has the advantage of giving an extra twist to the sac when drawn up and tightened.

If the rupture is small and recent, reaching only to the scrotal incision, the wire may be thus placed entirely behind the sac, between it and the cord; but if it is larger and of long standing, the close adhesions of the cord will hardly permit this, and the sac is unavoidably punctured posteriorly. The needle may also be made to take up a portion of the pillars themselves close to their insertions, in accomplishing which the crest of the pubis can be used as a guide and protector of the deeper parts, the needle being made to slide close to the bone. This additional precaution is very desirable in cases of large inguinal hernia occurring in females, in whom there is not much fascia capable of invagination at this point.

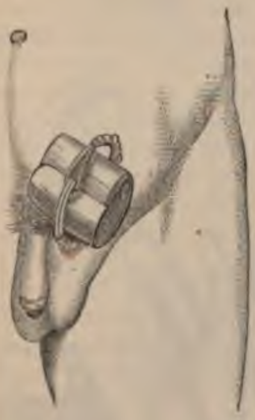
In some very small hernias, both in males and females, this last transfixion of the fascia or pillars may be dispensed with, since any great amount of invagination of the sac or fascia is not necessary to fill up a narrow hernial canal when drawn together by the suture. In some small hernias in women a simple incision over the superficial ring, without any separation of fascia, will permit the accurate application of the sutures, and afford a free escape for the discharges.

The next step is to straighten, stretch, and draw down both ends of the wire, until the loop above is close to the skin, where it is held by an assistant, while the surgeon twists the ends together, giving them three or four turns.

The loop is then drawn upward, invaginating the sac and scrotal fascia inclosed by the twisted ends firmly into the hernial canal, and then, in its turn, twisted well down into the puncture in the skin of the groin. Great care should be taken that the skin of the scrotum is not drawn in between the pillars of the ring, and the latter should also be examined through the scrotal incision to see if it has been satisfactorily closed.

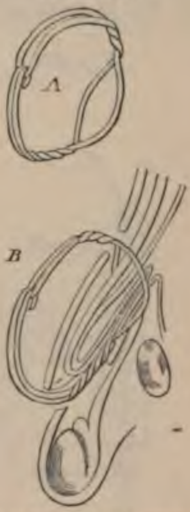
The projecting ends of the wire are cut off about three inches from the surface, bent into a hook, and engaged in the loop, forming an arch over the surface, in which a pad of lint is then placed (Fig. 221). A broad spica bandage is then placed over all.

FIG. 222.



Radical cure of inguinal hernia. Wires in place and fastened.

FIG. 223.

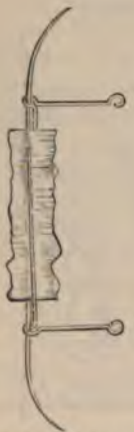


A. Wires as twisted. *B*. Vertical section showing disposition of the parts

Pin Operation (Wood).—In congenital hernia, and the smaller kinds of rupture in children and young boys, the canal is usually narrow, the internal opening contracted, and the sides elongated so as to retain much of their valve-like action. Moreover, the fascia and coverings are so thin that it is not of much use to transplant them into the canal. In consideration of these facts, Mr. Wood used rectangular pins (Fig. 224) instead of the wire loop. The pins are from three to five inches long, hard at the point, and soft in the shank, so as not to break, and spear-pointed with slightly cutting edges. They are applied separately in opposite directions, the point of each passed through the loop at the angle of the other, and the bent ends rotated in opposite directions so as to twist and compress the included tissues.

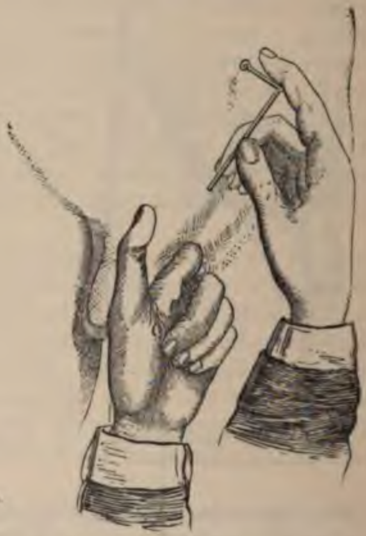
They are applied in the following manner: The child is placed upon his back, thighs flexed, and hernia reduced. The scrotum is invaginated into the canal, and the different parts recognized with the index or little finger, which is passed up the canal until the border of the internal oblique can be felt in front of it.

FIG. 224.



Pins used in the pin operation for the radical cure of hernia.

FIG. 225.

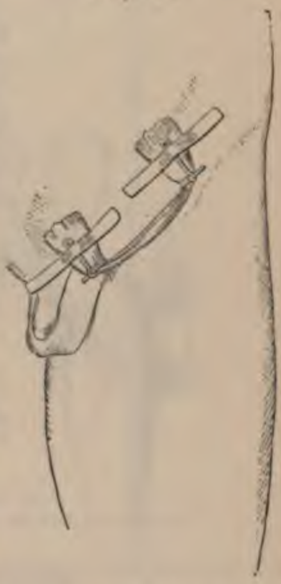


The skin is then drawn directly inward by an assistant, and a pin with its concavity directed downward, is passed through it and the intervening tissues to the inner side of the nail of the invaginating finger (Fig. 225). It is then slid downward along the side of the finger, which is, at the same time, withdrawn, until the point of the pin can be felt to touch the pubis. Skirting this bone, it is then carried into the scrotum and brought out through the skin over the fundus of the hernial sac, upon which the finger has been pressed. During this manœuvre, the point of the finger and the pin must move together, and the rupture must be kept up by pressing upon the internal ring with the little finger of the hand that holds the pin.

The second pin, with its convexity directed forward, is then entered by the scrotal puncture through which the first pin emerged, the invaginating finger placed below it, and the scrotum again pushed up into the canal, carrying the point of the pin along until it touches the posterior surface of the outer pillar of the superficial ring. Through this it is then passed upward and outward, so as to raise the skin of the groin directly below the deep (internal) ring. The skin is then drawn outward by an assistant, and it will be found that by turning the concavity of the pin inward, its point can be brought out through, or very close to, the puncture made by the entry of the first pin.

The point of each pin must then be passed into the loop of the other, a proceeding which will be much facilitated by first cutting off one of them so as to make it shorter than the other. After they have been thus fastened together the point of the other pin is cut off, and the bent ends twisted around once more by simply turning over the end of the upper pin toward the thigh. The punctures and skin are then carefully protected by lint or plaster, the bent end of the pins tied together or fastened down with plaster to prevent slipping (Fig. 226), and the whole bound down with a pad of lint and a spica bandage.

FIG. 226.

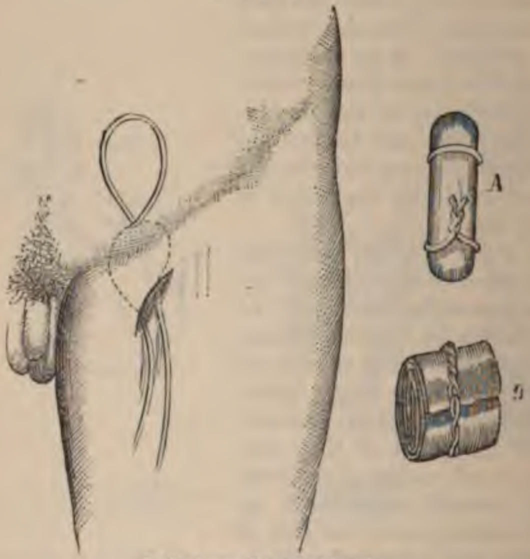


The pins in place.

In this operation the conjoined tendon and internal pillar are transfixed by the first pin, and the outer pillar transfixed and included by the second pin. The sac is transfixed by both pins, which lie for some distance in its interior. These parts are twisted together by turning one pin upon the other, so that the posterior wall is drawn forward and the anterior backward, and the canal is firmly closed. The cord lies between and behind the pins and is not included by them. The pins should be withdrawn about the tenth day.

Radical Cure of Femoral Hernia (Wood).—The instruments are the same as those used for the cure of inguinal hernia. Anæsthesia, dorsal decubitus, with the shoulders raised.

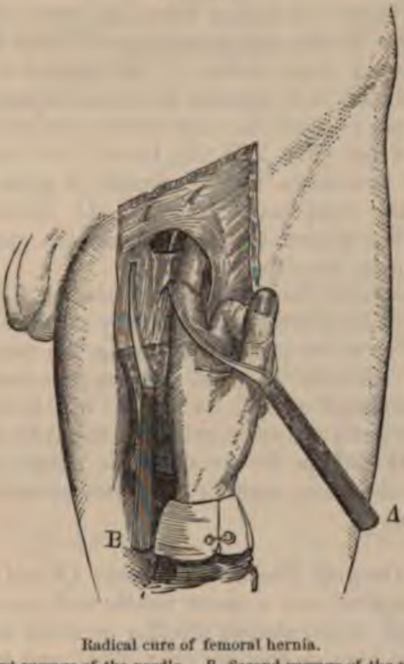
FIG. 227.



Radical cure of femoral hernia.

The rupture having been completely reduced, a vertical incision about an inch long is made through the skin over the site of the tumor (Fig. 227), and the adjoining fascia detached from the skin, as before described, to a sufficient extent to allow it to be invaginated fairly into the crural opening. The forefinger used for invaginating is then pressed against the inner side of the femoral vein, and the needle passed backward through the sac, taking up the pubic portion of fascia lata covering the pectineus muscle, reappearing in the wound, and then passing forward and upward through Poupart's ligament close to the nail of the invaginating finger (Fig. 228, *A*). The skin of the groin is then drawn outward by an assistant, the point of the needle passed through, the wire threaded upon it and drawn through by withdrawing the needle.

FIG. 228.



Radical cure of femoral hernia.
A. First passage of the needle. *B*. Second passage of the needle.

The needle is then disengaged from the wire and passed again through the pubic portion of the fascia lata for about an inch (the distance varying with the size of the hernial opening) on the inner side of the first puncture (Fig. 228, *B*), and its point passed in the same manner through Poupart's ligament directly above and close to the curved border of

Gimbernat's ligament, a portion of the fibres of which may be included. The skin is then drawn inward until the needle can be pushed through the puncture previously made, and which is already occupied by the wire. The other end of the wire is then engaged in the eye of the needle, drawn back through the wound, and disengaged (Fig. 227). The two ends of the wire are then twisted together in the incision and cut off about six inches from the twist, and the loop which emerges at the upper puncture twisted firmly down into it, pressing down before it the portion of Poupart's ligament included in it opposite the crural opening.

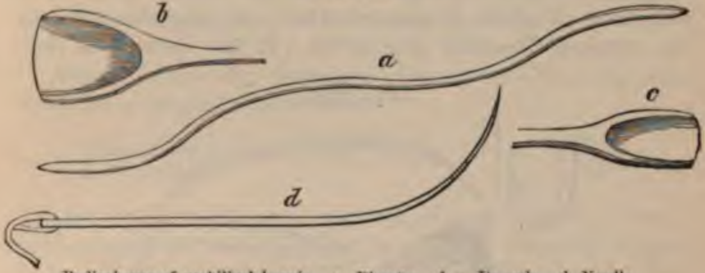
If the hernia is small the ends of the wire may be hooked over a pad of lint (Fig. 227, *B*), but if it is large and the ligamentous structures much relaxed, a cylindrical boxwood or glass compress (Fig. 227, *A*) should be used. Pledgets of lint placed on each side, and a spica bandage over all complete the dressing.

The precautions chiefly necessary during the operation are: First, to keep the finger carefully pressed against the femoral vein so as to protect it during the passage of the needle; and secondly, to avoid pushing the needle too far into the abdominal cavity, by which the bowel, the epigastric artery, and the spermatic cord might be endangered. The wire may be kept in for the same length of time and removed in the same manner as before described for inguinal hernia.

Radical Cure of Umbilical Hernia (Wood).—The instruments required are a stout needle well curved near the point, a small spoon-shaped director or scoop large enough to fill up the hernial opening (Fig. 229), and two pieces of stout silvered copper wire, each eight inches long.

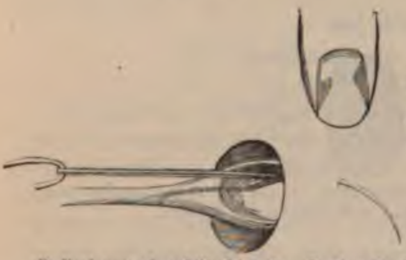
The patient is laid on the back, knees drawn up, and shoulders raised, and the hernia completely reduced. The convex surface of the bowl of the director is pressed into the hernial opening so as to carry the skin covering the sac quite behind the edge of the tendinous aperture on one side of the median line. The rounded end of the bowl must be pressed steadily and firmly against the under surface of the tendon, pushing the skin as far as possible along it. The needle, carrying one of the wires, is then placed in the hollow of the director, and the point pushed through the tendon from behind forward, well above the transverse diameter of the opening, the skin being at the same time drawn upward by an assistant so that it may be pierced at a lower level than the tendon is (Fig. 230). The wire having been drawn through, the needle is disengaged, attached to the second wire, and passed in the same way through the lower part of the tendinous border on the same side, the skin this time being drawn downward so that the needle may pass through or close to the puncture made before (Fig. 231). The second wire is then drawn through and the needle again disengaged.

FIG. 229.



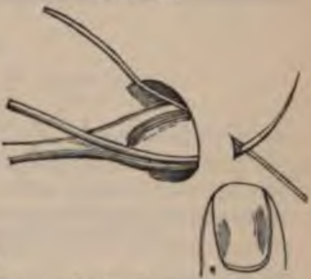
Radical cure of umbilical hernia. *a.* Director. *b, c.* Its ends. *d.* Needle.

FIG. 230.



Radical cure of umbilical hernia. Passing the first wire

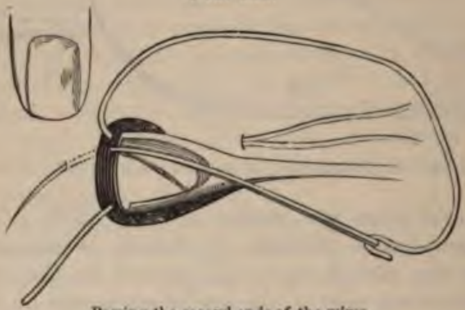
FIG. 231.



Passing the second wire.

This proceeding must now be repeated upon the opposite side with the other ends of the wires; the director must be placed firmly within the hernial opening, between and behind the two wires (which emerge through the skin at two points a short distance apart, in or near the vertical diameter of the opening), so as to push the skin well over to the other side of the median line behind the edge of the tendon, and make it possible to enter the needle at the same punctures at which it entered when carrying the wires in the opposite direction (Fig. 232). If the opening is very large, it will be necessary to slide the point of the needle close under the skin for a short distance before piercing the tendon.

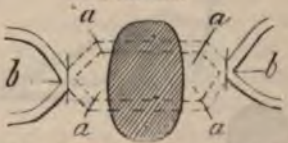
Fig. 232.



Passing the second ends of the wires.

The two wires are thus drawn across the opening and through its borders at equal distances above and below its centre, passing out on each side through the same puncture in the skin, and depressing the sac coverings within the area of the opening. When drawn tight they disappear into the punctures first made in the median line for the temporary purpose of their application (Fig. 233). If the hernial

Fig. 233.



Radical cure of umbilical hernia; wires in place. *a*, *a*, *a*, *a*. Points where the wires pass through the tendon. *b*, *b*. Punctures in the skin.

opening be very large a third wire may be applied in the same manner across the centre between the other two.

The ends of the wires on each side are then twisted together into the punctures until the opening is felt to be closed, then cut off at a suitable distance, and hooked together over a roll of lint, the whole being retained by a strap or two of adhesive plaster and a circular bandage.

Radical Cure by Injection (Heaton).—The injection material is prepared as follows:

Thayer's fluid extract of quercus alba . . .	℥ss.
Solid alcoholic " " " " . .	gr. xiv.

Triturate thoroughly with gentle heat until there is a nearly perfect solution; then add half a grain of sulphate of morphia. Heaton's needle has a flat lance-shaped point perforated at several places, but an ordinary hypodermic needle may be used.

Operation (Inguinal hernia).—The hernia is reduced, and the point of the index finger introduced well into the ring. The needle is then entered just below the ring, and passed upward between the pillars and the sac about half an inch, and about half a drachm of the solution injected into the tissues surrounding the neck of the sac within the canal. It must not be thrown into the cavity of the sac.

The irritation of its presence is expected to cause an increase of connective tissue and thus diminish the size of the opening.

IMPERFORATE ANUS OR RECTUM.

In order to understand their different congenital deformities, it is essential to bear in mind the manner in which the rectum and anus are developed. The rectum, like the rest of the intestine, is formed by the third blastodermic layer of the ovule, and originally communicates with the pedicle of the allantoid vesicle, that which afterwards becomes the bladder and the posterior portion of the urethra. The anus, on the other hand, is formed by a dimple in the outer blastodermic layer, the one which forms the epidermis. In the ordinary course of events the communication between the rectum and the bladder or urethra closes, and another forms between the rectum and anus by absorption of the layer of tissue between them. The malformations are the result of arrest of development of the colon, rectum, or anus, or of the persistence of the septum, and present several varieties.

The first, and slightest, is not a true arrest of development, but a simple closure of the orifice of the anus by a tegumentary layer or by adhesion of its sides, the deep communication between it and the rectum being complete. This requires only separation of the adherent edges with a director, or division of the layer with a knife.

2d. The rectum and anus may be fully developed, but the thin membranous diaphragm between them may persist, like the hymen in the vagina. The treatment of this also is simple: crucial incision or puncture of the membrane.

3d. The anus may be entirely absent, while the rectum is normally developed; the distance between the lower end of the latter and the surface being from half an inch to an inch.

4th. The anal cul-de-sac being properly developed, the rectum or colon may terminate at any distance above it, or may even not exist at all, being represented by a fibrous cord extending from the ileo-cæcal valve to the anus.

5th. The arrest of development may involve both the anus and the rectum.

6th. The rectum may open into the bladder, urethra, or vagina.

It is often exceedingly difficult to determine the character of the malformation during life, and yet it is very important that this should be done, for if the imperviousness begins at a point too high up to be reached through the perineum, the only possibility of relief is in the establishment of an artificial anus in the lumbar or inguinal region. Depaul[1] says that when the obstruction begins at the ileo-cæcal valve the transverse distention of the abdomen is much less than in rectal obstruction.

If the surgeon decides to go in search of the blind end of the rectum and create an anus in the perineum, he must make an incision in the median line from the scrotum to the tip of the coccyx, after having previously introduced a sound into the bladder if the patient is a boy, or into the vagina if a girl. He then divides the tissues layer by layer in the line of the incision, feeling at each step for the distended rectum, which can sometimes be seen and felt to bulge downward when the child strains or cries. Or, an exploratory puncture may be made, and the needle or trocar used as a guide if the bowel is reached by it.

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[1] Bull. de la Société de Chirurgie, 1877, p. 536.

The search for the bowel should be made in the direction of the axis of the anal cul-de-sac, if the latter is sufficiently developed, and advantage taken of the fact pointed out by M. Forget,[1] that a fibrous cord, representing a rudimentary portion of the rectum, occupies more or less of the distance separating the two. If, on the contrary, the anus is lacking, the search must be made toward the concavity of the sacrum. Verneuil has proposed to excise the coccyx, so as to diminish the danger incurred during the search, but as this is followed by prolapse of the rectum it should be practised only when a simple incision has proved insufficient.

When the end of the bowel is reached it must be seized with pronged forceps, or two stout ligatures must be passed through it, and it must be partly separated from the adjoining tissues, drawn down, opened, and made fast to the integument or the margin of the anus. The anterior and posterior portions of the cutaneous incision must finally be closed by sutures.

When the rectum opens into the vagina it may be reached through a longitudinal or crucial incision in the perineum, separated from the vaginal wall with a knife or curved scissors, and drawn down and fastened as before. The former opening will then close spontaneously.

PROLAPSE OF THE RECTUM.

The mucous membrane of the rectum is very loosely attached to the muscular coat, and when the sphincter is relaxed or disabled prolapse may occur to a degree that requires operative interference. This interference may involve the mucous membrane alone, or it may also include the anus. In the former case the indication is to promote adhesions between the mucous and muscular coats, or to remove portions that may be in excess; in the latter to narrow the anal orifice. The former is accomplished by making deep longitudinal incisions through the mucous membrane, or by pinching up folds at three or four different points and tying a strong ligature about each. The incisions are likely to give rise to severe hemorrhage, and consequently the method has fallen into disuse; the actual cautery, however, applied at points or in lines, has been used as a substitute.

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[1] Bull. de la Société de Chirurgie, 1863 and 1877.

There are two methods of narrowing the anal orifice. Dupuytren pinched up with forceps several of the radiating folds of integument and cut them off with curved scissors, trusting to cicatricial retraction for the narrowing he desired.

Robert made two incisions, extending from the extremities of the transverse diameter of the anus to the tip of the coccyx, removed the skin, subcutaneous tissue, and portion of the sphincter contained within the **V** thus marked out, and brought the sides of the gap together with sutures.

RECTOTOMY.

Cases of stricture of the rectum not suitable for dilatation or division by some of the specially contrived rectotomes, must be treated by section posteriorly in the median line. The sphincter is first forcibly dilated, and then a blunt director forced through the wall of the rectum in the median line below the stricture, and brought back into the rectum in the same line above it. Then by hooking a loop of stout wire over the point of the director I have always found it possible to draw the stricture as far down toward the anus that it could safely be divided layer by layer with the knife, and any bleeding points secured with ligatures. Or the wire of an écraseur may be passed in the same manner. The preliminary dilatation of the sphincter should be very thorough; and in some cases it is advisable to divide the sphincter posteriorly with the knife.

EXCISION OF THE ANUS AND PART OF THE RECTUM.

This operation may be rendered necessary by malignant disease, and may be performed with the knife, ligature, or écraseur. It must be remembered that the peritoneum descends upon the anterior surface of the rectum to within about an inch of the prostate, but not quite so far upon the sides or behind; its average distance from the anus is from two to two and one-half inches in front, and five inches behind; consequently, if the upper limit of the tumor on the posterior side cannot be reached by the end of the finger introduced through the anus, its removal should not be attempted. The nature and extent of its connections with the important organs on the anterior surface must also, of course, be carefully determined.

A. *Removal by the Knife.*—Two curved incisions, meeting in front and behind in the median line, are made through the skin, one on each side of the anus, and at a distance of about one inch from it. They are carried down to the rectum, remaining, of course, external to the neoplasm if it has broken through the rectal wall, and the rectum is then dissected upward as far as necessary, using the fingers instead of the knife for this purpose whenever possible. A sound should be introduced into the bladder as a guide if the patient is a man, and a finger into the vagina if the patient is a woman. When the upper limit of the tumor is reached, the rectum is drawn well down, its posterior wall divided longitudinally, and the diseased portion removed.

If the disease extends upward more than one and a half inches, it is advisable to make an additional incision backward to the tip of the coccyx, and perhaps even to extend it along the side of this bone.

Velpeau took the precaution to pass a number of threads through the intestine above the proposed line of excision, bringing them out through the skin beyond the external limits of the disease. After the removal of the tumor, he had only to tighten and tie these threads to bring the edges of the incisions through the intestine and the skin together.

Richard Volkmann[1] has modified this operation somewhat and claims that by thorough drainage and the strictest attention to disinfection of the wound during and after the operation, excision of the rectum can be carried to a very considerable height, and even the peritoneal cavity opened, without danger to the patient. He empties the bowel thoroughly, makes a circular incision about the anus, a straight one in the median line back from the circular one to the coccyx, and, if necessary, another in the median line of the perineum; the bowel itself must not be cut into. He then draws the rectum down, dissects it out circularly to the necessary height, passes ligatures through the healthy portion after Velpeau's plan, and cuts off the lower portion containing the tumor. Bleeding points are temporarily secured by self-retaining forceps, and afterward with catgut.

If the peritoneal cavity is opened, a sponge soaked in a salicylic acid or thymol solution is kept pressed against the opening, until the excision is completed; then if the opening is small its edges are drawn out with artery forceps, and a ligature thrown around it as if it was a vessel; if it is large, it is closed with catgut sutures.

The upper end of the gut is then drawn down, and fastened to the skin very accurately with alternate deep and superficial sutures, two or three drainage tubes are inserted, cut off close to the surface, and stitched fast.

During the operation, the bleeding surface is constantly protected against infection by irrigation with an antiseptic solution, and for the first three or four days constant antiseptic irrigation is kept up through a tube passed well into the wound near one of the drainage tubes; daily antiseptic injections are afterward made through the drainage tubes until the wound has healed.

Volkmann claims that these precautions strictly carried out insure the patient against what has heretofore been the chief danger of the operation, that of exciting diffuse pelvic cellular inflammation, which spreads rapidly upward behind the peritoneum, and causes death by septic peritonitis. Although the bleeding during the operation is very severe, he has never known it to have fatal consequences.

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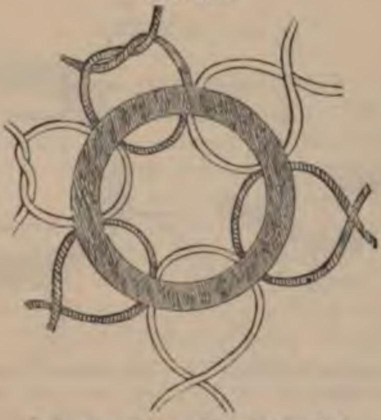
[1] Ueber den Mastdarmkrebs und die Exstirpatio recti in *Klinischer Vorträge*, No. 131 (Chirurgie, No. 42), p. 1113, 13th March, 1878.

He thinks, also, that cancer is much less likely to return locally after excision of the anus than it is when the sphincters are preserved, and, therefore, he prefers total excision of the anus and of the rectum to the upper limit of the disease, even when the anus itself is not involved.

I must add that the best result in my experience or observation, freedom from recurrence that has now lasted for seven years, followed removal of the tumor alone, a mass two and a half inches in diameter on the posterior wall of the rectum, and beginning one and a half inches above the anus. After dilatation of the sphincter I made an incision through it in the posterior median line up to the tumor, and cut the latter out with scissors, keeping one-third inch from it all around. The bleeding was free, but the vessels were readily secured. The sides of the gap were drawn together in the form of a +, the longitudinal incision closed with sutures, and a drainage tube placed behind the bowel and brought out at the posterior angle of the incision.

B. *Removal by Ligature.*—Récamier removed the lower end of the rectum and anus by including its entire circumference within a number of ligatures, which were tightly tied, and then left to cut their way out. He used two stout

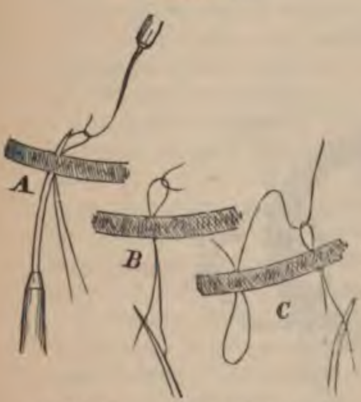
FIG. 234.



Extirpation of anus. Récamier's method.

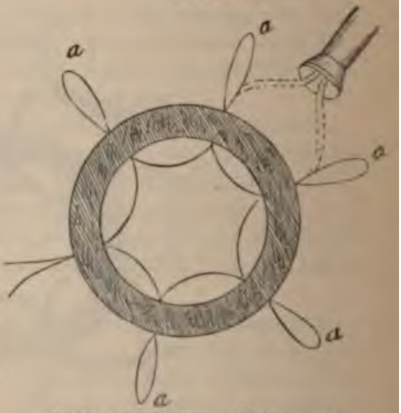
cords of different colors, passing them by means of a hollow curved needle, containing a central movable stylet, furnished with a large eye in its anterior end, and then tying the ends, which were of the same color, together in pairs (Fig. 234). The method is difficult of execution and painful, and has been advantageously modified by Maisonneuve, as follows: The surgeon marks with ink upon the skin the outer limits of the cancer, and divides the integument along the mark with the knife. He then places stout hempen threads as before, the loop lying inside the bowel, the end coming out through the incision in the skin. These threads may be placed by means of a needle like Récamier's, or by a curved needle with an eye large enough to carry two threads at a time passed from within outward, or by means of a long slightly curved needle mounted on a handle, and having an eye at its point. This needle is armed with a rather fine thread, and passed through the incision into the bowel above the tumor, where the thread is then caught with forceps or tenaculum, and the needle withdrawn (Fig. 235, *A*).

FIG. 235.



Method of surrounding the lower bowel with ligatures.

FIG. 236.



Extirpation of rectum. Maisonneuve.

A long, stout, hempen ligature is then passed through the loop of the fine ligature left within the intestine (Fig. 235, *B*), and drawn by means of it through the puncture made by the needles so that its centre comes out through the incision, and its two ends through the anus. Each end is then drawn through successive punctures in the same manner (Fig. 235, *C*), and after the bowel has been thus entirely surrounded, the external loops (Fig. 236, *a*, *a*, *a*) are cut.

The two ends of each short ligature, into which the long one has been thus cut up, are attached to a constrictor, and gradually tightened until the included tissues are divided.

C. *Removal by the Écraseur.*—Alphonse Guérin[1] has operated successfully by the following method. He first incised the skin around the anus with the knife, and then divided the rectum longitudinally with the écraseur from above the tumor to the tegumentary incision. Then by means of a curved needle he passed the chain of the écraseur horizontally about a portion of the intestine above the tumor and divided it, repeating this operation until the entire circumference of the rectum had been cut through. If the tumor does not involve the entire circumference, he circumscribes it by two vertical incisions, and divides only that portion of the circumference which lies between their upper ends.

HEMORRHOIDS.

Concerning the treatment of hemorrhoids by ligation there are a few points which deserve mention. The sphincter should be temporarily paralyzed by forcible dilatation. Every pile that is more than half an inch in diameter must be transfixed by a needle carrying a double ligature, and then strangulated by tying it at its base; the smaller piles do not need to be transfixed, it is sufficient to throw a single ligature about each. When the tegumentary margin is included in the ligature a groove should be snipped in it with scissors. The ends of the ligatures should not be cut off as soon as they are tied, but after three or four have been placed at opposite points of the circumference, it will be found easy to get an excellent view of the interior by drawing them outward and apart. The temporary paralysis of the sphincter not only facilitates the examination and operation, but it spares the patient pain during convalescence.

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[1] Chirurgie Opératoire, 4th edition, 1869, p. 582.

CHAPTER VII.

OPERATIONS UPON THE GENITO-URINARY ORGANS OF THE MALE.

CASTRATION.

AFTER the parts have been well shaved, the surgeon makes the skin covering the testicle tense, and makes a straight incision along the entire length of the anterior portion of the scrotum, beginning at a point just below the external abdominal ring. The testicle is then forced out through the incision and freed from its coverings more by tearing than by the use of the knife. The cord is isolated for the necessary distance, and divided at the lowest point allowed by the extension of the disease which has rendered the operation necessary.

Various modifications of the incision have been employed; Amussat and Roux made it upon the posterior surface of the scrotum, Jobert gave it the shape of a semicircle with its convexity downward and outward, Lafarge removed an elliptical portion of skin circumscribed by two curved incisions, and Rima removed the lower portion of the scrotum, and the testicle with it, by two transverse incisions made by transfixing behind the cord and cutting downward and backward for one of them, and directly forward for the other. If the layers of the scrotum are adherent to the testicle, and if the latter has become exceptionally large, the dissection must be carefully conducted so as to avoid injury to the erectile tissue of the penis and to the other testicle.

The cord may be ligatured *en masse*, or, better, in two parts after transfixion with a double ligature, and then divided half an inch below the ligature, the ends of which are cut long and brought out at the dependent angle. This is the method generally adopted; its advantages are the ease with which it is performed, its simplicity and security, and the facility with which the stump can be reached if hemorrhage occurs. The disadvantages are the possibility of causing tetanus by including the nerves in the ligature, and the length of time, a week or more, which is required for its separation. The alternative method is to transfix the cord with a stout ligature and divide it with a succession of short cuts, tying each vessel separately. The écraseur and galvano-cautery have proved inefficient to prevent hemorrhage. Malgaigne simply divided the cord and prevented hemorrhage by making pressure with a truss over the inguinal canal. It sometimes happens that consecutive hemorrhage occurs from the cord, and is sufficient to endanger the life of the patient; in such a case the wound must be reopened, and the bleeding vessel sought for within the inguinal canal, into which the cord has a strong tendency to retract; if necessary, the anterior wall of the canal must be divided.

Before closing the wound great care must be taken to secure all bleeding points in the scrotum by twisting or tying, for after no other operation is troublesome consecutive hemorrhage so common. The raw surface must be carefully examined and all clots picked off, in order that the vessels which they occlude may be more securely closed. The edges of the wound should be united with sutures, and a drain placed in the dependent angle.

HYDROCELE.

The operations for the relief of hydrocele are *palliative* or *radical*. The object of the former is simply to remove the liquid from the sac; that of the latter to prevent its reaccumulation by excising the sac, or by obliterating its cavity by exciting adhesive inflammation of its walls. Injection of the tincture of iodine is the means most commonly employed for the latter purpose. The position of the testicle within the sac should always be ascertained, in order that it may not be injured by the trocar. This is best accomplished in most cases by examining the sac by transmitted light, the testicle appearing as an opaque spot in the general translucency; its usual position is at the lower posterior portion of the sac.

Puncture of the Sac.—The tumor is grasped at its upper portion in such a manner as thoroughly to stretch the skin covering it, and a well-oiled trocar is plunged into the centre of its anterior surface, supposing the testicle to occupy its usual position below and behind. The depth to which the trocar enters is regulated by the finger placed along its side, and the surgeon satisfies himself that the point is well within the sac by moving it freely in all directions. The canula should fit the trocar snugly in order that its anterior end may not push the tissues before it instead of penetrating them. If the intention is only to remove the liquid, the canula is withdrawn as soon as the flow has ceased, and the puncture closed with adhesive plaster or collodion: but if a radical cure is to be attempted, the tincture of iodine must first be thrown in. The French surgeons use the tincture diluted with two or three parts of water, and prevent precipitation by adding iodide of potassium to the mixture. They throw a considerable quantity into the sac, retain it there for three, four, or five minutes, and then withdraw it. Van Buren and Keyes[1] recommend the "pure tincture thrown in gradually, retained several minutes, and worked around in such a way that every portion of the inner wall of the sac may come into contact with it;" the quantity of the tincture used should be equal to half the amount of liquid drawn off. Large hydroceles must first be reduced in size by one or two tappings. The injection of a few grains of carbolic acid dissolved in glycerine has given good results.

Care must be taken that the injection is not thrown into the subcutaneous connective tissue, an accident that is very likely to be followed by sloughing of the scrotum; the surest way of avoiding this accident is to throw in the injection before the liquid has entirely ceased to flow out. If the accident does occur, free incisions must be made at once into the scrotum at the seat of the infiltration.

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[1] Genito-Urinary Diseases with Syphilis, New York, 1874, p. 404.

Radical Cure by Incision (Volkmann).—The sac is freely laid open by a longitudinal anterior incision, and the incised edges of the skin and tunica vaginalis stitched together all around. Excessive reaction is prevented by antiseptic dressing. If the wall of the sac is much thickened, it must be dissected off and excised.

VARICOCELE.

The treatment of varicocele may be palliative or radical. By the former, support is given to the testicle and the over-distended veins; by the latter, it is sought to obliterate the lumen of the veins at one or more points. There are several risks involved in the radical treatment, which, when taken in connection with the usual harmlessness of the affection and the efficacy of palliative measures, should make the surgeon slow to employ it. The risks are: Possible phlebitis, which may lead to pyæmia; possible atrophy of the testicle, in consequence of the obliteration of all the veins or the inclusion of the artery in the ligature; and finally, the likelihood of a return of the affection if all the veins are not obliterated. The palliative treatment consists in wearing a suspensory bandage, or in excising a large portion of the scrotum, with the expectation that what is left will act as a natural suspensory.

Excision of the Scrotum.—A long clamp is required, between the blades of which a large fold of the scrotum is pinched up parallel to and including the raphe. This fold is then cut off about one-eighth of an inch from the outer side of the blades, and numerous interrupted sutures applied before the clamp is removed. If bleeding is feared, these sutures should be cut about a foot long, and not tied until after the clamp has been taken off, and all bleeding points secured.

The radical treatment consists in obliterating the lumen of the veins by dividing them with the knife or the cautery, excising a portion of their length, compressing and strangulating them by means of ligatures or clamps, or simply exposing them to the air.

Division and excision are unsafe, even when the veins are compressed above and below by harelip pins and twisted sutures.

Compression by Pins.—The bundle of veins is pinched up and carefully separated from the cord and artery, which lie close together behind the veins and can be readily distinguished by the firm whipcord-like sensation given by the former when it is rolled between the thumb and fingers. The pin is then passed through transversely between the veins and the cord, and an elastic or a silk ligature thrown around its ends. It is well to place two pins about an inch apart.

Compression by Wires (Vidal's method).—Vidal passed a stout wire between the veins and the cord, as before described, and a thinner wire through the same holes in the skin, but in front of the bundle of veins (Fig. 237). The two wires were then twisted together (Fig. 239), so as to compress the veins included between them, and turned a few times so as to roll up the bundle of veins around them (Fig. 238). Ulceration occurs at the point of compression, and the inflammation spreads to the adjoining parts, matting the veins together, and occluding them in several places. Dubrueil has modified this by making the thin wire form part of a galvanic circuit and raising it to red heat.

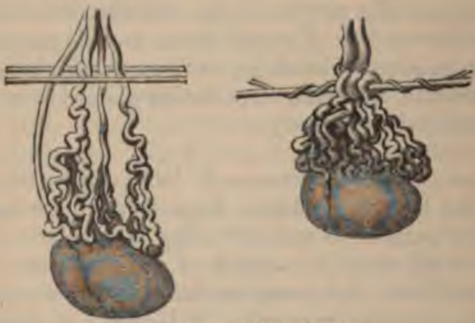
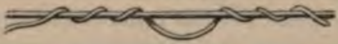


FIG. 237. FIG. 238.

Vidal's operation for varicocele.

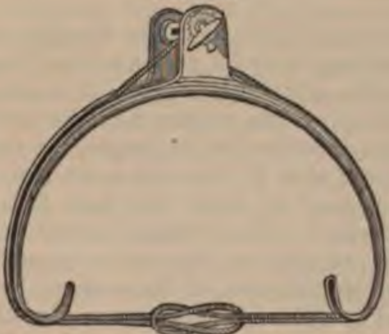
Subcutaneous Ligature.—A needle carrying a catgut or antiseptic silk ligature is passed through between the veins and the cord, reëntered at the point of emergence, passed around the other side of the veins close under the skin, and brought out and tightly tied at the first point of entry. If this is very exactly done, so as not to include the deeper part of the skin at either puncture in the loop, and is treated antiseptically, it will usually heal without suppuration. Its execution is facilitated by making the punctures with a knife.

FIG. 239.



Ricord's Method.—Ricord passed a needle carrying a thread between the veins and cord, made the thread fast to the loop of a stout ligature and drew it through, leaving the loop projecting through one puncture, the two ends through the other. The needle and thread were then passed again in the opposite direction, through the same punctures, but in front of the veins, and a second ligature drawn through. The ends of each ligature were then passed through the loop of the other, drawn tight so as thoroughly to compress the veins, and then attached to the apparatus shown in Fig. 240, and tightened every day

FIG. 240.



Ricord's method of tying the veins in varicocele until the bundle was cut through. Or the ends may be tied together over a roll of bandage placed in front between the two punctures, and tightened daily.

Rigaud's Method by Exposure.—Prof. Rigaud, of Strasburg and Nancy, has had great success in obtaining obliteration by simple exposure of the veins to the air. He pinches up a transverse fold of skin, transfixes it and cuts out, dissects out the bundle of veins carefully, passes a strip of well-greased linen under it, and binds a pad of charpie over it. The veins shrink as soon as they are exposed, the blood coagulates in them immediately, and in a few days spontaneous division occurs, or they are reduced to a fibrous cord. At the time his paper was written[1] he had operated upon nineteen varicoceles and one hundred and forty cases of varicose veins of the leg. In three cases the veins were accidentally opened, and those three cases died of pyæmia; all the others were entirely successful.

AMPUTATION OF THE PENIS.

If the amputation is to be made through the pendulous portion hemorrhage may be prevented by tying a ligature tightly about the root of the organ. It is generally stated that the erectile portions retract more extensively than the skin, and must therefore be cut longer, but this appears to be incorrect, the skin is more retractile than the corpora cavernosa, and must be drawn well back toward the pubis before it is divided. The division may be made with the knife, écraseur, or cautery; there is no objection to the use of the former on the score of hemorrhage, but it is more often followed by pyæmia than either of the others.

In order to prevent cicatricial contraction of the urethral orifice the inferior wall of that canal should be divided, together with the skin, for about half an inch, and the edges of the mucous membrane made fast to those of the skin with fine sutures. Some surgeons consider this longitudinal incision unnecessary, and are satisfied to draw out the mucous membrane slightly and stitch it fast to the skin. If the longitudinal incision is to be made, it is desirable to cut the urethra, if possible, half an inch longer than the corpora cavernosa. Singular as it may seem, it is sometimes difficult to find the orifice of the urethra on the surface of section.

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[1] Bulletin de la Société de Chirurgie, 1875, p. 464.

If the amputation is to be made close to the symphysis, two accidents must be guarded against; they are: retraction of the penis, and infiltration of urine into the scrotum. To prevent the former, a stout ligature should be passed through the sheath of the penis a little above the point selected for amputation; to prevent the latter, and also to give the patient better command of the direction of his stream of urine, the scrotum should be divided in the median line and the anterior and posterior edges of each half brought together, so as to form two distinct scrotums with the urethra exposed between them.

OPERATIONS FOR PHIMOSIS.

Dorsal Incision.—A director is passed through the preputial orifice along the dorsum of the glans to the corona, a curved, sharp-pointed bistoury guided along it, the skin transfixed at the point of the director and divided straight down to the preputial orifice. Nothing more is absolutely required, for the wound left to itself will heal promptly; but it is well to round off the corners and to unite the edges of the mucous membrane and skin by fine sutures. This is a very satisfactory operation when the prepuce is not redundant, but if there is much excess of tissue the foreskin will present an awkward, lop-eared appearance for many years, and in such cases, therefore, circumcision is to be preferred.

This operation is often required in cases of sub-preputial chancroid, and then it becomes a matter of considerable importance to prevent inoculation of the wound by the chancroidal virus. A method introduced by Dr. J. H. Lowman into the venereal wards of Charity Hospital, New York, has proved very efficient in this respect. A solution of nitrate of silver, forty grains to the ounce, is injected under the prepuce, and followed by the injection of a saturated solution of common salt, to remove the excess of the caustic. The sore having been thus rendered temporarily innocuous by the coagulation of its secretions, the incision is made and the sore cauterized with nitric acid.

Circumcision.—A number of instruments have been invented, and a great variety of methods proposed, which do not need to be repeated here, for the object they had in view, that of insuring division of the skin and mucous membrane of the prepuce at the same level, is not a matter of much importance, since any excess of the latter can be readily removed afterward. There is, however, one modification introduced by Dr. Keyes[1] which is of great importance, for it insures the removal of the constriction and protects the wound from being harmed by erections while healing. This modification consists in an additional longitudinal division of the skin for about half an inch along the dorsum of the penis, and sometimes, also, on the opposite side along the course of the urethra, after the end of the prepuce has been cut off (Fig. 242, *AC*). The corners left by these incisions are rounded off, and the effect is to increase the circumference by twice the length of the incision. As the stricture is sometimes due to insufficient breadth of the skin covering the glans, the value of this simple modification is evident.

Operation.—A probe is first introduced and swept over the surface of the glans to break up any adhesions that may exist, and the edge of the preputial orifice is then caught at opposite points with the thumb and forefinger of each hand and drawn forward, care being taken to make the tension upon the less elastic mucous membrane, and not only upon the skin. While the prepuce is thus drawn forward, an assistant clasps a pair of long narrow-bladed forceps vertically upon it just in front of the apex of the glans, directing the blades forward as well as downward (the penis being horizontal) parallel to the general direction of the corona, and the glans should then be moved freely behind them to make sure that it is not caught between the blades. The portion of prepuce in front of the forceps is then cut away with scissors or a knife (Fig. 241), and the forceps taken off.

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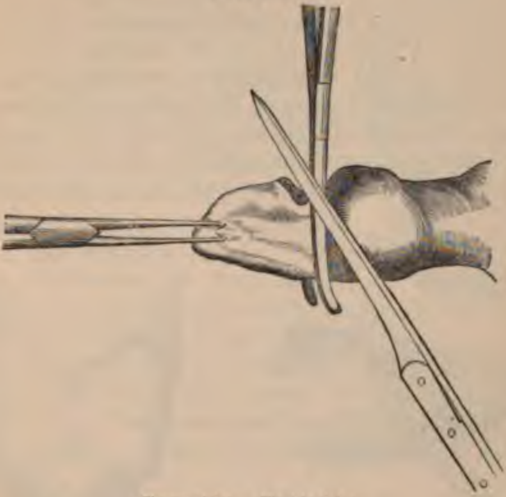
[1] Van Buren and Keyes, Genito-Urinary Diseases, with Syphilis, New York, 1874, p. 11.

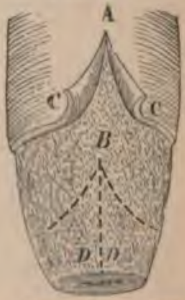
FIG. 241.



Circumcision First incision.

It will then be seen that the glans is still covered by a more or less tightly fitting sheath of mucous membrane, while the looser and more elastic skin retracts to or beyond the corona, leaving a belt of raw surface below (Fig. 242).

FIG. 242.

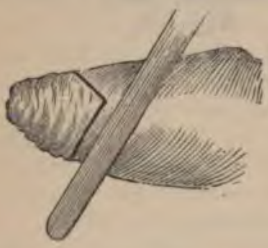


Circumcision. Raw surface left by retraction after first incision.

The mucous membrane is next divided with scissors along the dorsum back to the corona (Fig. 242, *BD*), and the skin divided in the same direction along the dorsum for a distance of half an inch from its cut edge (Fig. 242, *AC*), and also on the under side along the urethra, if considered necessary. The corners of these incisions are rounded off, and the edges of the mucous membrane and skin fastened together with numerous fine sutures, the first being placed exactly in the median line in front, the second at the frenum. If fine silk is used, and the sutures placed close to the edge, they may be left to cut their way out and come away in the dressings.

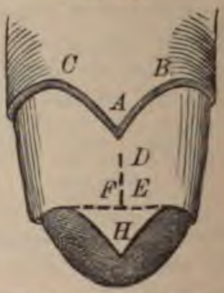
It is always difficult to get accurate adjustment of the edges at the ends of the longitudinal incisions on the dorsum, and usually a small triangular gap is left to fill by granulation. Dr. D. B. Delavan[1] proposes to meet this objection by leaving a triangular piece projecting in the centre of the dorsal portion of the cutaneous incision. Fig. 243 shows the line of incision, Fig. 244 the resulting triangles of skin and mucous membrane; the apex of the latter, *H*, which at first is drawn upward by its close connection with the apex of the skin triangle, *A*, so that its mucous surface is outward, is represented in the figure as it appears after having been freed by dissection, if necessary, and turned down, leaving its raw surface out. The mucous membrane is then slit up to the corona at *D*, as usual, after cutting away its triangle, and the point *A* is stitched fast to *D*, *B* to *E*, *C* to *F*, and the remainder of the edge as usual.

FIG. 243.



Circumcision. Delavan. First incision.

FIG. 244.



Circumcision. Delavan. Fitting in the triangle.

The only objection to be made to this device is that it sacrifices the liberating longitudinal incision of the skin, and Dr. Keyes[2] has met this by taking the triangular flap from the mucous membrane instead of from the skin. He cuts off the prepuce by a straight incision, and divides the skin along the dorsum as before; and then, instead of splitting the mucous membrane in the same manner (Fig. 242, *BD*), he makes a **Y**-shaped incision (Fig. 245, *BDC*), and removes the anterior strip of mucous membrane by continuing the incision from *C* and *D* around to the frenum. The point *DBC* is then reflected, fitted into the triangular gap *GEF* left by the longitudinal incision in the skin and the rounding of its corners, and the edges are united by sutures, as before.

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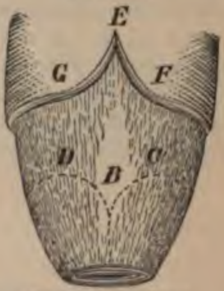
[1] Oral communication, 1876.

[2] Oral communication, 1876.

FIG. 245.



Circumcision. Keyes.

If broad adhesions exist between the glans and prepuce, and it is feared that the raw surfaces left by their division will reunite, all the mucous membrane may be removed, except a ring about one-eighth of an inch wide adjoining the corona; the skin is then loosened by dissection from the underlying tissues, drawn forward, and united to the narrow ring of mucous membrane. The raw surface on the glans, having nothing to adhere to, cicatrizes naturally.

PARAPHIMOSIS.

A description of the methods of reduction by taxis or by compression of the engorged prepuce and glans does not lie within the proposed scope of this work, and the operation of division of the constricting band hardly needs to be described, for it consists simply in dividing the band from without inward at one or more points, until the constriction is sufficiently relieved to allow the prepuce to be drawn forward. It is well to make the first incision in the median dorsal line so as to profit by it afterward, if an operation for phimosis is considered necessary. If inflammatory adhesions have formed along the line of the constriction, forcible attempts to reduce the paraphimosis should not be made, but, after division of the band, the parts should simply be dressed with cold and soothing lotions.

DIVISION OF THE FRENUM.

Verneuil[1] employs the following method: He makes the frenum tense, transfixes it close to its attachment to the glans with a narrow bistoury or tenotome held with its side parallel to the surface of the penis, and cuts out backward, making a triangular flap nearly half an inch long, with its apex directed backward. The liberated glans is drawn forward, the flap disappears, and the edges of the wound, which assumes the shape of a lozenge, are united by sutures.

EPISPADIAS.

The deformity known as epispadias is characterized by fissure of the roof of the urethra. In its complete form it is associated with separation of the symphysis pubis, and often with exstrophy of the bladder, in which case its treatment is subordinate to that of the more important defect (*q. v.*). In its slightest degree it is confined to a fissure occupying the dorsal portion of the glans penis, and extending from the meatus to the corona (epispadias balanique). The existence of this form has been denied, but Verneuil[2] reports two cases, in neither of which did the malformation cause any disturbance of function. In the more important varieties the urethra lies above the corpora cavernosa instead of below them, and is open on the roof from its anterior extremity nearly to the bladder; the glans is fairly developed, and may be grooved more or less deeply along its dorsum, while the rest of the corpus spongiosum is represented by a thin layer of erectile tissue under the urethra. There is sometimes partial or complete incontinence of urine, and the operative indication is to supply a channel through which the urine can be conducted without dribbling to a urinal.

Nélaton's Method.—The prepuce is drawn downward and forward by means of a ligature passed through it, and held in this position during the operation. An incision is then made along each side of the urethral gutter at the junction of the skin and mucous membrane, beginning at the prepuce and ending at the abdominal wall. The external lip of each incision is dissected up for about one-sixth of an inch, forming a flap on each side continuous with the skin; the inner lip of each incision is also slightly loosened. The flaps must be made as thick as possible.

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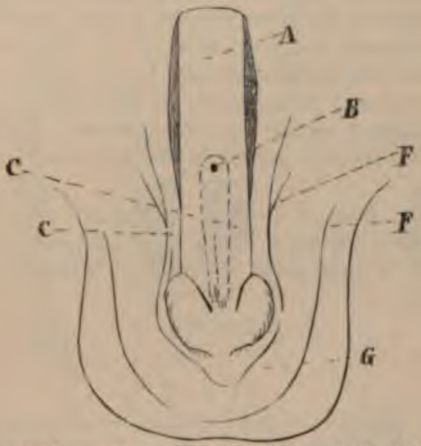
[1] Chirurgie Réparatrice, 1877, p. 730.

[2] Loc. cit., p. 718.

A third flap is then marked out upon the abdominal wall, immediately above the urethral orifice leading to the bladder, by two vertical incisions united at their upper ends by a transverse one; it should be as broad as, and a little longer than, the penis, dissected from above downward to its base, which corresponds to the interpubic ligament, and then reversed, its cutaneous surface inward, and its sides made fast by sutures to the inner lips of the incision on the penis, care being taken to make the contact as broad as possible. Demarquay[1] and Dolbeau[2] preferred to make the flap by prolonging the first two incisions up the abdomen, thinking

FIG. 246.



Epispadias. Nélaton's operation. *A.* Abdominal flap. *B.* Urethral infundibulum. *C, C.* Lateral incisions at junction of skin and mucous membrane. *F, F.* Scrotal incisions circumscribing *G* the scrotal flap.

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[1] Maladies Chirurgicales du Penis, 1877, p. 623.

[2] De l'Epispadias, Paris, 1861. Planche IV., Fig. I.

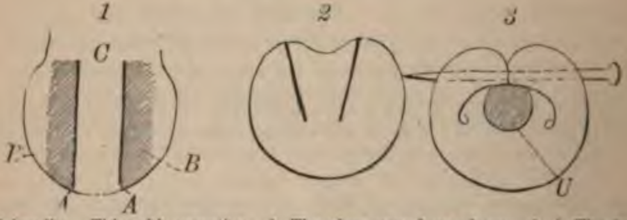
that the continuity of the incisions upon the abdomen and penis would increase the chances of success (Fig 246, *CC*).

In order to give the abdominal flap greater thickness, and prevent its retraction during the process of cicatrization, Nélaton reinforced it by another taken from the scrotum. This scrotal flap is limited by concentric curved incisions (Fig. 246, *FF*), the upper one circumscribing the under half of the root of the penis in the peno-scrotal angle, the other at a distance below the first equal to the length of the penis, and is left adherent at both ends. After the flap has been dissected up, the penis is passed under it, bringing the raw surface of the reversed abdominal flap into contact with that of the scrotal flap, and the great circumference of the latter is fastened by three sutures to the outer lips of the two incisions made along the sides of the urethral gutter.

The canal thus formed is very large, and both Nélaton and Dolbeau found it necessary to diminish its size by applying the actual cautery to its interior. The operation devised by Thiersch is generally deemed superior.

Thiersch's Method.[1]—This operation requires several months for its completion, since it is composed of four distinct operations performed at different times. In order to prevent the urine from coming into contact with the raw surfaces of the flaps Thiersch makes an opening into the

FIG. 247.



Epispadias. Thiersch's operation. 1. The glans seen from above. *A*, *A*. The incision on each side of the gutter *C*. *B*, *B* The freshened surface. 2. Transverse section of glans showing the incisions 3. The freshened surfaces brought together and closing in the urethra *U*.

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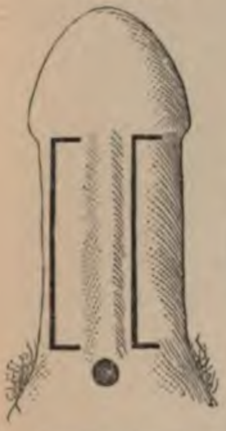
[1] Archiv für Heilkünde, 1869, pp. 20–36, and Langenbeck's Archiv, vol. xv. Part II. p. 379.

urethra through the perineum and maintains it during the entire period of treatment.

First Step (Fig. 247).—Creation of the meatus and the portion of the canal occupying the glans. The surgeon makes a deep incision along each side of the urethral groove in the glans, pares the surface of the outer lip of each incision, brings the freshened surfaces into contact, and fixes them with two or three points of twisted suture.

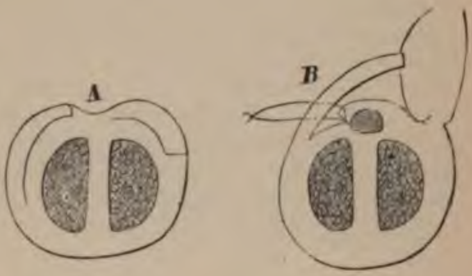
Second Step (Figs. 248, 249).—Creation of the urethra along the body of the penis. The surgeon makes an incision through the skin and subcutaneous tissue at the edge of the urethral gutter on the right side, makes a short transverse cut outward from each end, and dissects up the rectangular flap thus marked out. On the left side he makes a longitudinal incision one centimetre external to the edge of the gutter, and a transverse incision from each end. This flap is dissected up, making it as thick as possible, and turned over so as to form a roof for the urethral gutter, its cutaneous surface directed downward, its raw surface upward. Several ligatures are passed through it near its free border

Fig. 248.



Epispadias. Thiersch. Second step Incisions limiting the two lateral flaps.

Fig. 249.



Epispadias. Thiersch. Transverse section of penis, showing flaps.

and then through the base of the right-hand flap, and the latter drawn across the former so that their raw surfaces are brought into contact throughout. The free edge of the right flap is then fastened to the skin forming the outer edge of the incision on the left side.

Third Step.—To close the gap remaining between these two new portions of the urethra. A transverse incision is made in the prepuce, the glans passed through it, the borders of the gap pared and fastened to the edges of the incision in the prepuce.

Fourth Step.—To close the posterior portion of the canal or infundibulum. The method employed is similar to that used in the second step of the operation, the flaps being taken from the groins. The left flap has the form of an isosceles triangle, and its base occupies the left half of the upper semi-circumference of the opening; it is turned over so that its cutaneous surface is directed downward, and its free border is united to the freshened posterior edge of the roof of the new urethra. The other flap is quadrilateral, its base corresponds to the right inguinal ring, and it is drawn over the first one so that their raw surfaces are brought into contact and fastened together with sutures.

Finally, the fistula established in the perineum is closed.

HYPOSPADIAS.

The deformity known as hypospadias is characterized by a congenital abnormal opening of the urethra upon the under surface of the penis. Sometimes the urethra ends at the abnormal opening, sometimes it is continued more or less imperfectly beyond it, either in the form of a tube, which is usually imperforate at one or two points, or in that of a gutter. The varieties of hypospadias are usually classified in three groups, the balanitic, penile, and scrotal, according as the abnormal opening is found at a point in the urethra corresponding to the glans, the pendulous portion of the penis, or the scrotum. The balanitic is the most frequent and least important, and the penile is less frequent and less important than the scrotal. The defect never extends further back than the bulb of the urethra, and consequently never causes incontinence of urine. In the scrotal and in some of the penile varieties the anterior portion of the urethra forms a tense fibrous cord binding down the glans, curving the body of the penis upward, and preventing its erection.

In the balanitic variety, when the anterior portion of the urethra exists in the form of a gutter, no treatment is required unless the opening is too small. The slight deficiency in length involves no loss of function, and attempts to reconstitute the defective portion of the canal by some plastic operation usually fail. In fact, if the canal exists between the meatus and the abnormal opening, it is better to slit it up than to try to close the latter.

The scrotal variety is considered irremediable, and has never been the subject of surgical interference. In it the scrotum is bifid, the penis usually very small, and the urethral orifice at the bottom of an infundibulum resembling a vulva. Individuals thus deformed have often been mistaken for hermaphrodites and sometimes for females.

In the penile variety, when the anterior portion of the urethra is normal, the opening may be closed by freshening the surface about its edge and covering it with a flap taken from the adjoining skin. When the anterior portion exists only in the form of a more or less shallow groove, it may be transformed into a complete canal by one of the methods of urethroplasty hereinafter described. The two other modes of operating, urethroraphy and perforation, have now been discarded; in the former the edges of the groove were pared and brought together with sutures, in the latter a trocar was passed along through the tissues of the under side of the penis from the extremity of the glans to the abnormal opening of the urethra, and the route thus created kept open by the frequent passage of sounds.

If the penis is incurvated it must be straightened as a preliminary to any operation. To accomplish this it is not sufficient to divide only the fibrous band on its under surface, for the retraction is partly maintained by the shortness of the inferior portion of the sheaths of the corpora cavernosa and the septum between them. If the skin on the under surface is flexible enough to allow the penis to be straightened after the internal bands have been divided, this division may be made subcutaneously, following the example of Bouisson, by introducing a tenotome and pressing its edge against the sheath of the corpora cavernosa and the septum while the glans is drawn steadily away from the scrotum. Ordinarily, however, this is not possible, and one or two transverse incisions one centimetre long must be made through the skin and deeper parts. By the straightening of the penis these transverse incisions are transformed into longitudinal ones, and their sides are then drawn together by sutures. Several months must then be allowed to elapse before the subsequent plastic operation is undertaken, in order that the cicatrix may become perfectly soft and attain its full vitality.

In the earlier operations of *urethroplasty* the floor of the urethra was formed by a long narrow vertical flap taken from the scrotum, its base adjoining the orifice of the urethra, and its borders fastened to the edges of two longitudinal incisions on the under side of the penis. In short, the method resembled that already described as employed by Nélaton for the relief of epispadias, even to the reinforcement of the flap by a transverse one taken from the skin above the root of the penis. The results of these attempts were so unsatisfactory that when Nélaton was consulted, in 1872, concerning a patient affected with hypospadias, he advised that nothing should be done, saying that he had made many canals through which the urine was carried to the end of the penis, but they interfered with erection, and did not facilitate fecundation.[1] The surgeon who received this advice, Théophile Anger, thereupon devised another method, ignorant that a similar one had been employed shortly before by Thiersch in epispadias and by Scymanowski for urethral fistula, and, having put it into execution, obtained an excellent result.

Théophile Anger's Method.—In this case the urethral opening was at the peno-scrotal angle, the anterior portion of the canal was entirely lacking, and the penis was so curved that the extremity of the glans was not more than half an inch from the opening. The penis was first straightened by two short transverse incisions carried to such a depth that the corpora cavernosa were exposed at the bottom of the wound; the bleeding was slight, and the wound healed promptly. The plastic operation was performed nearly four months afterward, and was only partially successful, the posterior portion of the flap disappearing by absorption. A second operation, six months later, was entirely successful, and the condition of the parts, when the patient was shown to the Société de Chirurgie five months afterward, was entirely satisfactory; the tissues were supple, there was no stricture in the canal, and erection was perfect, except for a very slight incurvation downward.

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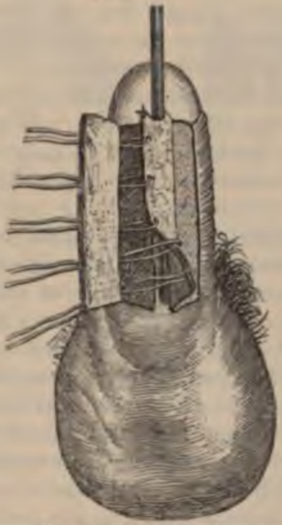
[1] Théophile Anger in Bull. de la Soc. de Chirurgie, séance du 21 Janvier, 1874.

FIG. 250.



Hypospadias. Théophile Anger's method.

The first plastic operation was as follows: An incision, extending from the glans to the scrotum, was made through the skin on the left side parallel to the median line and one and a half centimetres from it, and from each extremity of this an oblique incision was carried to the median line, the posterior one ending on the scrotum just behind the urethral opening (Fig. 250). The cutaneous flap circumscribed by these three incisions was dissected up so that it could be turned back with its epidermic surface directed inward, and thus constitute the floor of the new canal. A second longitudinal incision was then made a little to the right of the median line, parallel to and as long as the first, a transverse incision one and a half to two centimetres long carried outward from each end of it, and the flap thus circumscribed dissected up.

A sound was then introduced into the urethra, the first flap drawn back over it, and six sutures placed close to its free longitudinal border; the two ends of each suture were then attached to a needle and carried through the base of the second flap from within outward, as shown in the figure, drawn tight, and fixed by pinching a tube of lead upon them. Finally, the second flap was drawn over the first, and its edge made fast to the outer lip of the first incision, thus covering in all the raw surface.

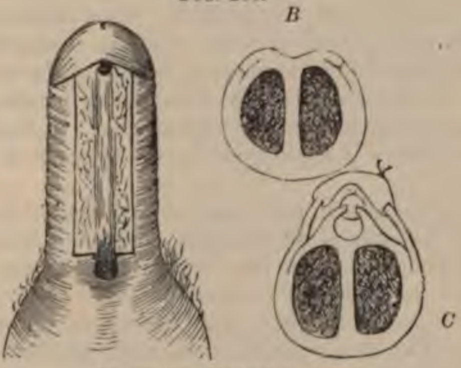
Anger tied in the catheter and left it for several days, but admits that this was a mistake. When he repeated the operation he left the catheter in for only twenty-four hours, and then reintroduced it only when the urine had to be drawn off.

Duplay's Method.—The operation has three steps or stages. In the first, the penis is straightened and a meatus made; in the second, the portion of the urethra which is lacking is restored; and in the third, this new portion is united to that which previously existed.

First Step.—The penis is straightened by transverse or subcutaneous incision as before described, and the meatus made by paring a strip of the surface of the glans on each side of the groove representing the urethra, and bringing them together with one or two points of twisted suture over a piece of gum catheter placed in the groove. If necessary, the groove may be deepened by one or two longitudinal incisions on its floor (roof of the urethra).

Second Step.—Two longitudinal incisions, extending from the glans nearly to the abnormal urethral opening, are made, one on each side of the median line, at a distance from each other equal to the circumference to be given to the new urethra; and from each end of these a short transverse incision is made toward, but not quite to, the median line (Fig. 251, *A*). The rectangular flaps thus circumscribed are dissected up toward the median line, turned back over a gum catheter, and their free borders fastened together with sutures (Fig. 251, *B* and *C*). The outer lips of the

FIG. 251.



Hypospadias. Duplay's method.

two incisions are then loosened sufficiently by dissection to allow them to be drawn over the others and fastened together in the median line with interrupted or twisted sutures. Care must be taken to attach the anterior ends of all four flaps to the pared surface of the glans, so that the new urethra may be continuous with the piece previously made.

Third Step.—To close the gap between the termination of the old and the beginning of the new portions of the urethra, Duplay freshened the edges and brought them together with double rows of sutures.

URETHRAL FISTULÆ.

Urethral fistulæ, as a rule, are more difficult to close the further they are from the bladder. Those occupying the perineum and scrotum are long, pass through thick tissues, and will usually heal spontaneously if the full calibre of the urethra in front of them is maintained. Occasionally it becomes necessary to freshen their sides with the knife, caustics, or cautery.

Fistulæ occupying the pendulous portion of the penis have but little tendency to close spontaneously, unless they are recent and small; the distance between the mucous and cutaneous surfaces is so short that the walls of the fistula cicatrize promptly without uniting, and that renders a spontaneous cure practically impossible. Operations undertaken for the purpose of closing them, exclusive of simple cauterization, are divided into two classes, *urethroraphy* and *urethroplasty*. In the former, the sides of the fistula are pared and brought together in the median line; in the latter, the loss of substance is made good by the transfer of cutaneous flaps.

It has always been held that the principal obstacle to the closure of a fistula is the frequent passage of urine through it, and although this has been occasionally questioned, especially with reference to normal, unaltered urine, it is still considered one of the principal indications to prevent this passage. The choice lies between three methods: 1st. Introducing a catheter and drawing off the urine as often as it becomes necessary to empty the bladder; 2d, tying in a catheter; 3d, establishing a free passage for the urine at some point on the proximal side of the fistula. Each method is open to serious objections; the frequent passage of the catheter is calculated to disturb the adjustment of the flaps, stretch the sutures, and irritate the urethra; and, moreover, a small quantity of urine is sure to escape through the canal beside or behind it. A catheter retained in the urethra for several days is even worse; as Ducamp[1] pointed out more than fifty years ago, it violates the two conditions necessary to the cicatrization of every wound, moderate degree of inflammation and of humidity, by irritating the canal, provoking an excessive flow of mucus, and acting upon the wound itself as a pea does in an issue. After two or three days at the latest it not only fails to remove the urine as fast as it collects in the bladder, but actually favors its escape alongside and through the wound. It excites cystitis of the vesical neck, and sooner or later gives rise to the complex of symptoms known as urinary fever. In short, it is not only inefficient after the first day or two, but is positively harmful. The objections to the third method, unless perineal fistula exist and can be sufficiently enlarged, are that as usually practised it involves a considerable wound in the perineum, which may itself give rise to a fistula more obnoxious than that which it is designed to cure, and that by destroying the integrity of the spongy tissue of the bulb it causes dribbling and imperfect ejaculation of the last of the urine. Recent experience, however, indicates that a catheter can be safely passed through the anus and the recto-vesical wall close behind the prostate, and the bladder drained through it for several days without danger of establishing a recto-vesical fistula; and if on further trial this should prove to be the case, the indication in question can be more satisfactorily met in this way than by any of the other methods.

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[1] Traité des Rétentions d'Urine, 1825, p. 237; quoted by Verneuil.

Urethroraphy.—This term is applied to the simple approximation of the sides of a fistula after they have been pared. Verneuil[1] considers the method applicable to all circular fistulæ not more than one-fifth of an inch in diameter if the surrounding tissues are thick, and also to oblong fistulæ of much greater size when their long axis is in the median line and their sides can be easily brought together. He thinks the numerous failures which have followed the use of the operation have been caused by a lack of attention to details, and he suggests that the paring of the edges should be oblique so as to give the fistula the form of a funnel with its apex at the opening into the urethra, the mucous membrane of which should not be included in the paring. Fine metallic sutures should be used, applied at short intervals, not penetrating to the canal of the urethra, and tied over a leaden plate on the surface. The line of reunion should be longitudinal, not transverse, and if primary union is not obtained the sutures should be retained to favor secondary union. During the operation a sound should be kept in the urethra in order that the canal may have its full size.

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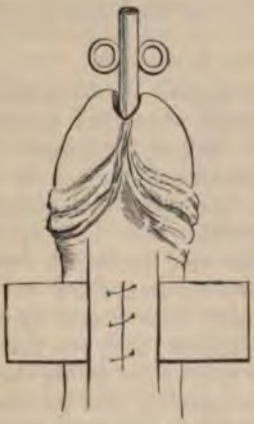
[1] Chirurgie Réparatrice, p. 696.

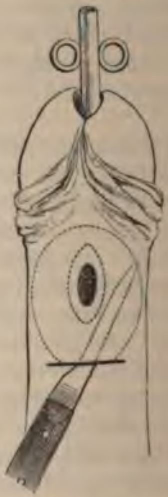
Urethroplasty.—The methods that have been suggested and employed have been very numerous, but most of them count more failures than successes. This is especially true of those by which longitudinal or transverse flaps have been dissected up on opposite sides of the fistula and brought together by their edges across its centre, for the tissues are usually too thin to afford a sufficiently broad surface of coaptation, and the urine finds its way at once through the wound. It has been proposed to overcome the latter obstacle to union by passing a piece of thin India-rubber under the flaps (Fig. 252), but it is doubtful if the presence of the foreign body would not have a more unfavorable effect upon the thin, delicate flaps than the urine which it is intended to keep away.

FIG. 252.



Urethroplasty.

FIG. 253.



Urethroplasty. Nélaton.

Nélaton's Method.—Nélaton pared the edges of the fistula and dissected up the skin subcutaneously for about an inch around it by entering the knife through a short transverse incision below it (Fig. 253). The skin thus liberated was pinched up in a longitudinal fold along the median line, and fixed in this position by twisted or quilled sutures.

Reybard made the dissection through the fistula, thus avoiding the transverse incision of the skin. *Dieffenbach* and *Delore* employed a similar method, but instead of dissecting up the skin subcutaneously they raised two longitudinal or transverse flaps and fastened them together by their raw under surfaces (not edges) in the centre, the former passing his sutures through a leather splint on each side, the latter applying them in three rows, one above the other.

Delpech and *Alliot* dissected up a single flap, drew it entirely across the fistula, and fastened it to a raw surface prepared upon the opposite side.

Sir Astley Cooper cut away the skin in such a manner as to leave a raw surface of quadrilateral form with the fistula in its centre, and then covered it with a flap of the same shape, taken from the scrotum by the Indian method of autoplasty.

Arlaud[1] obtained a complete success in a remarkable case, where the urethra had been completely divided just in front of the peno-scrotal angle, and its two cut ends were nearly an inch apart, by adapting a method previously employed by Roux to close a fistula in the trachea. The principle is the same as in Delpech's method, the difference in detail being that two flaps are used instead of only one; the second one, that which has its cutaneous surface pared, being drawn under the first.

Two transverse flaps, one in front of the fistula, the other behind it, were marked out by longitudinal incisions four centimetres apart; the anterior one was dissected up for a distance of two centimetres toward the glans, and the posterior one dissected back over the scrotum, until it could be easily drawn forward far enough to cover the fistula entirely. The anterior portion of the cutaneous surface of the second (scrotal) flap was then thoroughly pared, the flap drawn forward so as to cover the fistula, and the anterior flap drawn back over the other and fastened there by four points of twisted suture and one serre-fine.

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[1] Bull. de la Société de Chirurgie, 1857, p. 550, and Verneuil's Chirurgie Réparatrice, p. 654.

Sédillot dissected up a small flap on each side, its base adjoining the edge of the fistula, its free border directed outward, reversed and united them by their free borders in the median line (their epithelial surfaces directed inward), and brought the sutures out through the meatus. The raw surface of the flaps was then covered by a third flap transferred by the Indian method, or by sliding.

Rigaud closed a large fistula at the peno-scrotal angle by the method already described as Nélaton's method of treating epispadias. He took a quadrilateral median flap from the scrotum, its base adjoining the fistula, turned it forward over the fistula, and covered its raw surface with two flaps taken from the sides and drawn together to meet in the median line.

Théophile Anger has likewise proposed to close urethral fistulæ by the method he employed so successfully in a case of hypospadias; and

Scymanowski[1] reports a success obtained by a method which differed but slightly from Anger's. He made the flaps much longer than the fistula, and freshened the cutaneous surface of the reversed flap by blistering it, so that it could unite with the raw surface upon which it was laid.

Dr. McBurney, by the use of methods similar to the last named, has obtained a number of brilliant successes in urethral fistula and hypospadias; several of the cases are reported in the proceedings of the New York Surgical Society between 1881 and 1884. In cases in which previous operations had failed and had left cicatricial tissue about the opening he sought to close, he first removed the cicatricial tissue and supplied its place with flaps taken from the adjoining skin. To close the openings he used flaps similar to Anger's (Fig. 250), leaving the epidermis upon the surface of the one first turned in over an area corresponding exactly to the opening, and freshening with the knife all the remaining portion of its surface. He also dissected up for a line or two the anterior edge of the central unfreshened portion and tucked it under the freshened anterior margin of the opening.

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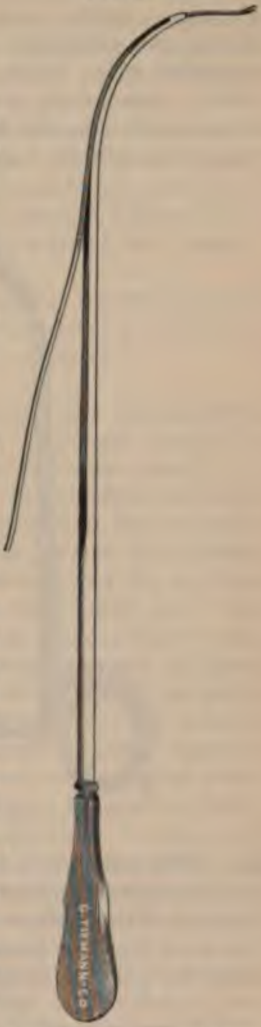
[1] Handbuch der Operativen Chirurgie, 1870.

FIG. 255.

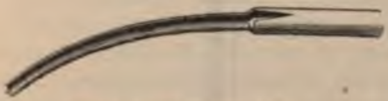


Tunnelled instrument and whalebone guide.

EXTERNAL PERINEAL URETHROTOMY.

A. *With a Guide.*—Prof. Syme, who introduced this operation, employed as a guide a staff, the straight portion of which was of full size, and its curved portion much smaller and grooved on the convexity. The change from the full to the small size was abrupt, not gradual (Fig. 254). This instrument has been superseded, in the United States at least, by the tunnelled instruments introduced by Prof. Van Buren,[1] which are passed into the bladder over a fine whalebone bougie as a guide, the beak of the instrument being bridged over or drilled out for a distance of about one-quarter of an inch, so that it can be slipped over the bougie (Fig. 255). If a Syme's staff or a tunnelled catheter cannot be had, any instrument may be used which can be got into the bladder, but it is a great advantage to be able to pass a full-sized instrument step by step as the stricture is divided.

FIG. 254.



Syme's staff for perineal section.

The patient is placed in the lithotomy position (dorsal decubitus, thighs flexed upon the abdomen,[1] ankles made fast to the wrists), the perineum shaved, the whalebone guide introduced into the bladder, a tunnelled silver catheter of full size, grooved on the convexity, passed down over it to the stricture and confided to an assistant, who also draws the scrotum forward out of the way. An incision, varying in length according to the position of the stricture, is made in the median line, and the end of the catheter exposed. If the stricture is deeply placed the sides of the incision must now be held apart by means of two stout ligatures passed through them, one on each side, while the guide is carefully followed from before backward

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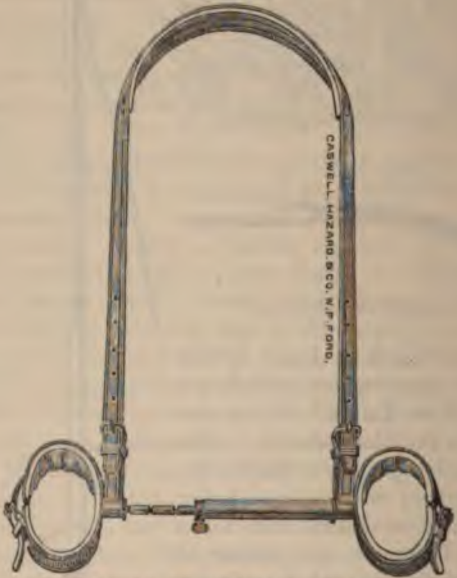
[1] Van Buren and Keyes, Genito-Urinary Diseases, p. 127.

FIG. 256.



Clover's crutch, for operations upon the perineum with short cautious strokes of the knife in the median line, and the catheter pushed along as the route is opened, until the posterior limit of the stricture having been passed, it slips into the bladder. Care must be taken not to divide the whalebone guide by a careless stroke of the knife.

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[1] A convenient method of keeping the thighs flexed is to pass a stout cane under the knees and fasten it with a cord or roller bandage passed from one end around the back of the patient's neck to the other end. An instrument has been specially constructed for the purpose (Fig. 256), but a stout stick does very well.

If Syme's staff is used, the incision is carried down until the groove in the curve of the staff can be felt by the finger; the handle of the staff is then grasped with the left hand, the point of a narrow bistoury passed into the groove behind the stricture, and the latter divided by cutting from behind forward.

Any bands that are found on the roof of the urethra must be divided, and a full-sized steel sound passed to make sure that the stricture has been thoroughly relieved.

B. *Without a Guide.*—The cases are very rare in which a filiform whalebone bougie cannot be passed through a stricture which allows urine to pass, and consequently external urethrotomy without a guide is not often required. The patient is placed in the lithotomy position, the perineum shaved, and a full-sized catheter passed down to the stricture and confided to an assistant, who also draws the scrotum forward, keeping its raphé exactly in the median line. An incision, two and a half to three inches long, is made in the median line, and the end of the catheter exposed by opening the urethra one-quarter of an inch in front of the stricture. The catheter is then partly withdrawn, the sides of the wound held widely apart by means of stout ligatures passed through them, and an effort made to pass a fine probe or whalebone bougie through the stricture from before backwards; if the effort succeeds, the operation becomes one "with a guide," and is completed as before described. If the probe can be passed for only a short distance, a line or two, the tissues are divided upon it, and the attempt renewed until the canal behind the stricture is reached.

If these efforts fail entirely, the urethra must be sought for behind the stricture—a most difficult task unless a perineal fistula exists through which a guide can be passed into the bladder, or unless this portion of the urethra is distended with urine and can be punctured in the median line. Van

Buren and Keyes[1] recommend that the surgeon should feel for the hole in the triangular ligament, and cut into it through the fibrous mass by repeated strokes with the knife, always in the median line. Others prefer to pass the index finger of the left hand into the rectum, place it against the apex of the prostate, and continue the dissection backward with a view to opening the urethra at that point. When this has been accomplished, a sound is passed from behind forward to the posterior face of the stricture, and the latter divided as thoroughly as possible between the two sounds.

If the stricture lies in front of the triangular ligament the centre of the arch of the pubes is an invaluable guide, toward which the incisions should be constantly directed.

Perineal Urethrotomy for Exploration of the Bladder (Thompson).—The instruments needed are a median grooved staff and a long straight, narrow-bladed knife, with the back blunt to the point. Having placed the left index-finger in the rectum and introduced the staff, the knife is introduced, edge upward, about three-quarters of an inch above the anus, with or without a small preliminary incision of the skin, until the point reaches the staff about the apex of the prostate, where it divides the urethra for half an inch, and is then drawn out, cutting upward a little in the act, but so as to avoid any material division of the bulb. The index-finger is then slowly passed into the bladder through the wound as the staff is withdrawn, and the interior of the bladder explored with the aid of firm pressure above the pubes with the other hand.

EXSTROPHY OF THE BLADDER.

The first operation for the relief of this deformity was performed, according to Gross, by Prof. Pancoast, of Philadelphia, in 1858; according to Erichsen, by Dr. Daniel Ayres, of Brooklyn, in 1859. The deformity is much more frequent in males than in females, and the operative indication is to cover in as much as possible of the exposed mucous membrane and facilitate the adaptation of a urinal by making the urine escape through a comparatively small opening; for, as the sphincter cannot be restored, there will always be incontinence. The method employed is the same as Nélaton's for epispadias: a tegumentary flap is raised from the abdomen above the bladder, reversed so as to cover the latter, and then covered itself in turn by lateral flaps, one from each side.

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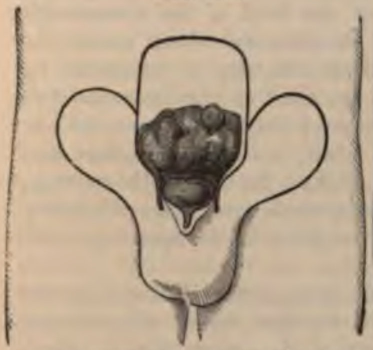
[1] Diseases of the Genito-Urinary Organs with Syphilis, p. 125.

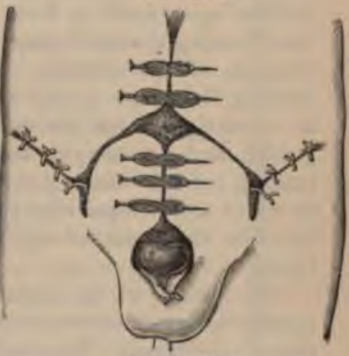
The first flap (Fig. 257) should be square, its base adjoining and slightly broader than the upper margin of the opening, its length should be sufficient to cover in the bladder completely when turned down over it. A pyriform flap is dissected up on each side, its breadth equal to the length of the first flap, and its base directed downward and inward, as shown in Fig. 257, or downward and outward so as to require less twisting and include more of the cutaneous branches coming from the femoral artery. These two flaps are then drawn across the reversed umbilical flap, meeting in the median line, and are fastened to each other with twisted sutures, the pins including a portion of the thickness of the umbilical flap also, so as to keep the raw surfaces in contact (Fig. 258).

FIG. 257.



Wood's operation for exstrophy of the bladder. Incisions.

FIG. 258.



Flaps in place.

The edges of the gaps left by the removal of the flaps are drawn together as well as possible with twisted and wire sutures, broad strips of adhesive plaster applied to give support and relieve tension, and the patient kept in bed in a sitting posture with the knees drawn up. The sutures may be removed at the end of a week.

CATHETERIZATION (WITH CURVED METAL CATHETER).

The obstacles to the passage of a catheter, exclusive of stricture and of false passage, are found either at the triangular ligament in the membranous, or in the prostatic portion of the urethra. As the fixed portion of the canal begins anteriorly at the opening in the subpubic or triangular ligament, the flaccid pendulous portion in front of this point may be carried aside if the catheter is held improperly, and doubled upon itself in front of the beak of the instrument, thus forming a sort of pouch or cul-de-sac which arrests the progress of the catheter. This difficulty is overcome by drawing the penis gently up the shaft of the instrument so as to straighten out the portion of the canal yet to be traversed, and by keeping the beak in the median line and making it follow the roof rather than the floor of the urethra, so as to avoid especially the normal pouch-like dilatation found on the under side just in front of the opening in the ligament.

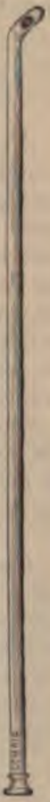
The obstacle in the membranous portion is caused by the spasmodic contraction of the muscles which envelop this part of the canal. The nature of the obstruction is recognized by the tight grasp of the instrument by the muscles, the quivering of the fibres transmitted through it to the hand of the surgeon, and by the knowledge of the fact that the instrument has reached this part of the canal where organic obstacles do not often exist. The difficulty is overcome by making gentle pressure with the beak of the catheter in the proper direction, so as to tire out the muscles.

The most serious obstacle is found in the prostatic portion, and is due either to inflammatory swelling of the mucous membrane or of the gland (abscess of the prostate), or, much more commonly, to senile change in the shape and size of this organ. A description of the nature of these changes and lesions does not come within the scope of this work, and the reader is referred for them to special treatises upon the subject. It is sufficient here to say that in the former case the inflammation must be reduced or the abscess evacuated *secundum artem*, or, failing this, the bladder must be punctured above the pubes, or through the rectum. In the other case, catheters of different curves should be tried, such as Mott's long catheter of large curve, or Mercier's single or double-elbowed catheter (Fig. 259). It is also well to pass the forefinger of the left hand into the rectum to make sure that the catheter has entered at the apex of the prostate, and that it has not passed out of the canal into a false passage, and to try to lift its beak over the obstacle by making direct pressure upon the curve in front of the prostate, while the handle is simultaneously depressed.

If these means fail, and soft instruments of gum or vulcanized rubber cannot be introduced, the bladder must be punctured.

Passage of the Catheter.—The patient having been brought to the side of the bed or placed upon a lounge, the surgeon, standing on one side, preferably the left, separates the lips of the meatus with the thumb and forefinger of the left hand, introduces the beak of the catheter, previously well warmed and oiled, and passes it down to the penoscrotal angle, holding the shaft of the instrument parallel to the groin. He then sweeps the handle around to the median line of the abdomen, keeping it close to the surface, draws the penis gently up the shaft, and presses the instrument bodily downward toward the feet; as soon as the beak reaches the lower border of the symphysis he draws the scrotum up and presses the catheter gently onward, still holding it parallel to the body, and then when the beak has closely approached or engaged in the opening in the triangular ligament he gradually raises the handle, brings it forward in the median line, and depresses it between the thighs. Failure to enter the opening in the triangular ligament is indicated by the bulging of the curve of the instrument in front of the symphysis, its rebound when the slight pressure on the handle

FIG. 259.



Mercier's elbowed catheter

is removed, and the mobility of the beak when the handle is gently rotated about its longitudinal axis.

As the shaft passes the vertical line the root of the penis and the integument covering the symphysis should be pressed down with the palm of the right hand laid broadly upon it, so as to stretch the suspensory ligament.

PUNCTURE OF THE BLADDER.

Above the Pubes.—The only instrument required is a straight, or, better, a curved trocar and canula, the trocar having a groove in its side which permits a small stream of urine to pass as soon as the bladder is reached. The surgeon satisfies himself by percussion that the distended bladder rises well above the pubes, and then making the skin tense with the thumb and fingers of his left hand, he plunges in the trocar about an inch above the symphysis pubis in the median line, the concavity of the instrument turned toward the bone.

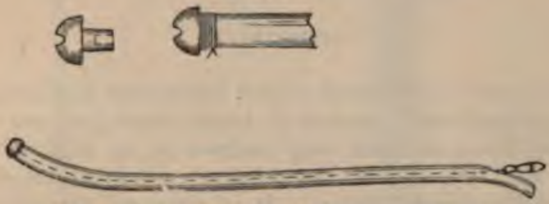
Some surgeons prefer to make a preliminary incision in the median line, and others (Holmes) even continue the use of the knife until the bladder can be felt at the bottom of the wound.

Under the Pubes.—Voillemier once punctured below the pubes, because the bladder was so contracted that he did not think it safe to approach it from above, and the prostate so large that its upper border could not be reached through the rectum. The penis was drawn downward, and a curved trocar, with its concavity directed upward, entered close under the symphysis.

Through the Rectum. A. *From without inwards.*—The patient having been anæsthetized, the surgeon passes his left forefinger into the rectum and places its tip against the posterior face of the prostate between the seminal vesicles. He then passes the trocar along the finger and plunges it into the bladder with a sharp, vigorous push, so as to insure its passage through the wall and its penetration to a sufficient depth. After withdrawal of the trocar the canula is tied in, or a gum catheter is passed through it to retain it in position.

B. *McBurney's Method.*—Dr. McBurney[1] has introduced a very convenient method of passing the catheter from within the bladder out through the anus. A metal button resembling the head and part of the shaft of a medium sized round-headed screw, and hollowed out for a short distance at its small end, is inserted into the end of a soft rubber catheter and tied fast to it (Fig. 260). A well-oiled staff, slightly curved at the beak, is passed through the eye of the catheter and its point engaged in the hollow end of the metal button. The catheter is stretched along the staff, so as to keep the point of the latter firmly fixed in the button, and passed into the bladder.

FIG. 260.



Puncture of the bladder through the rectum. McBurney.

The index and middle fingers of the left hand are then passed into the rectum, the posterior border of the prostate and the seminal vesicles recognized, the catheter reversed so as to press the button down in the median line between the two fingers in the rectum and then confided to an assistant who holds it steadily in place while the surgeon passes a blunt-pointed bistoury, the blade of which is wrapped to within an inch of the point, into the rectum between his fingers, and cuts through the intestinal and bladder walls upon the button. As soon as the button slips through into the rectum the staff is withdrawn and the other end of the catheter is drawn into the bladder by bringing the button out through the anus. Care must be taken not to draw it too far, that is, entirely through into the rectum, and if there is any urine present its escape through the catheter as soon as the eye enters the bladder tells the surgeon when to stop.

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[1] Oral communication, 1877.

Dr. McBurney at first used a button with a conical head, which Dr. Thomas T. Sabine modified by rounding it and adding the groove shown in the figure. By keeping this groove in the antero-posterior plane and cutting into it as into the groove of a lithotomy staff the execution of the operation is facilitated. Dr. Sabine also makes the incision with a gum lancet instead of a guarded bistoury.

LITHOTRITY.

The modern lithotrite is a steel instrument consisting of a straight shaft eleven inches in length, having at one end a "beak" about an inch long inclined at an angle of from 110° to 130°, and at the other a cylindrical roughened handle containing a screw. It is composed throughout of two parts, one fitting accurately in a deep groove in the other, and having at the handle a male screw which can be thrown into and out of gear by means of a button upon the other part. While trying to catch a stone the screw should be out of gear, in order that the male blade may be advanced and withdrawn more rapidly, but when the stone has been fairly caught the button must be pressed back and the screw-power used to crush it.

Many different patterns have been proposed for the beak or jaws with the view either of securing the thorough pulverization of the fragments, or of preventing the clogging of the instrument by the impaction of the mortar-like detritus between the jaws. The latter difficulty can be overcome by leaving the jaw of the female blade entirely open, that is, with a large fenestra extending from side to side and from the extremity of the beak to its angle, and by making the male blade long enough to allow its jaw to be passed entirely through the female one and even to project beyond its convex surface. In its simplest terms, then, the jaws should consist of two parallel bars, one-fourth of an inch apart, between which a third one, fitting loosely in the gap, can be forced. Of course, the male jaw must not be allowed to project beyond the convex surface of the female one during its passage through the urethra.

A small fenestra at the angle of the beak will not prevent clogging, although it may diminish it if there is a corresponding projection at the heel of the male jaw, as in Fig. 263; and it is open to the very serious objection that it may lodge a sharp angular fragment, which, projecting beyond its edges, will lacerate the neck of the bladder and the floor of the urethra during the withdrawal of the instrument.

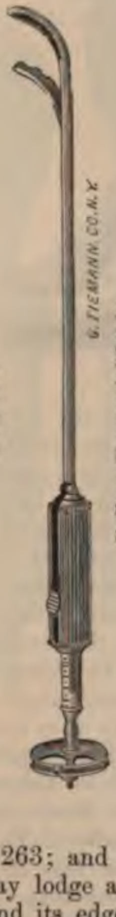


Fig. 261.

Sir Henry Thompson's lithotrite.

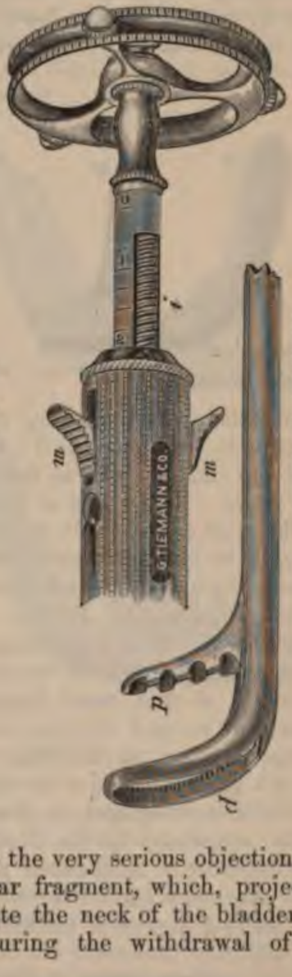
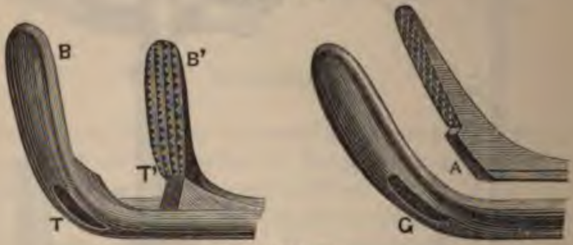


Fig. 262.

Keyes's fenestrated lithotrite.

The arrangement of open spaces in the female jaw corresponding to guttered projections or teeth upon the male jaw, as in Reliquet's model, is entirely insufficient to prevent clogging. The detritus packs across the gaps and presents an absolute bar to the closing of the instrument. Whenever such corresponding teeth and spaces are used they should be cut to fit each other very loosely, that is, with a clear space of at least one millimetre between them.

FIG. 263.



"Scoop" lithotrite.

For catching and crushing small fragments the "scoop" lithotrite is commonly used; the jaw of its female blade is broad and shallow, with no fenestra or with only a small one at its angle. The edges of both jaws should be bevelled, and the male considerably narrower than the female, so that they may be brought together with the least possible danger of including a fold of mucous membrane between them.

Prof. Bigelow,[1] of Boston, recommends an instrument (Figs. 264 and 265) combining, as he claims, the advantages of the fenestrated and the scoop lithotrites. The female jaw is shallow, so that small fragments are easily caught and crushed in it, and clogging is prevented by deep notches opening outward on the sides of the male jaw (Fig. 265), and by a small fenestra at the angle to provide for the escape of the detritus engaged in the groove of the female blade. He also substitutes for the button on the handle of Thompson's lithotrite a mechanism partly shown in Fig. 264, by which the screw can be thrown into gear by a turn of the hand holding the end of the male blade; and, further, curves the beak of the instrument to facilitate its passage through the prostatic urethra. It must be admitted, however, that with a soft, phosphatic stone the instrument will become impacted; and when the stone is large and hard the connecting catch is liable to be torn away. I prefer, therefore, the instrument recommended by Prof. Keyes (Fig. 262); it cannot clog, and the lateral catch cannot be broken by any force exerted through the screw.

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[1] American Journal of Medical Sciences, Jan. 1878.

Fig. 264.

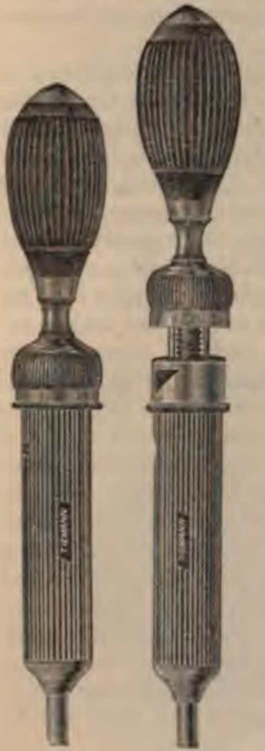
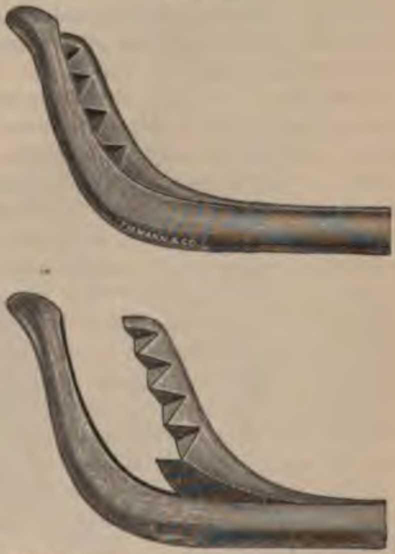


Fig. 265.



Bigelow's lithotrite.

Operation.—The patient is prepared for the operation by diminishing irritability of the bladder, if it exists, and by having him retain his urine, if possible, for an hour and a half or two hours before the operation is begun. He is then placed upon his back, with his hips raised upon a firm pillow or cushion in order that the stone may gravitate away from the neck of the bladder, and the surgeon, standing at his right side, introduces the well-warmed and oiled lithotrite in the manner described for the introduction of a catheter. Great care must be taken not to depress the handle too soon, a mistake which is likely to be made on account of the apparently great depth to which the instrument has to penetrate before the bladder is reached.

As soon as the instrument has entered the bladder, it is allowed to glide across it, its shaft being held steadily in one position, and if the stone is free it will generally be touched on the way The surgeon then gently turns the beak away from the stone, withdraws, with his right hand, the male blade for a distance determined by previous measurement of the stone, presses the jaw of the female blade gently against the floor and posterior wall of the bladder, rotates the beak toward the stone, and closes the male blade upon it. As soon as the stone is felt to be firmly caught the beak is rotated back to the vertical position, and the screw thrown into gear by pressing back the button on the handle with the thumb of either hand. The lithotrite, with the stone in its grasp, is then drawn away from the posterior wall and rotated to either side to make sure that the mucous membrane is not caught between its jaws, and then, grasping the cylindrical handle firmly with his left hand, he crushes the stone by turning the screw with his right, and continues this action until the register upon the handle shows that the male blade has been driven well home. The screw is then thrown out of gear, the male blade drawn back, the beak turned again toward the spot where the stone was caught, and the instrument closed whether the fragments are felt or not, for it may be confidently expected that they will be found there.

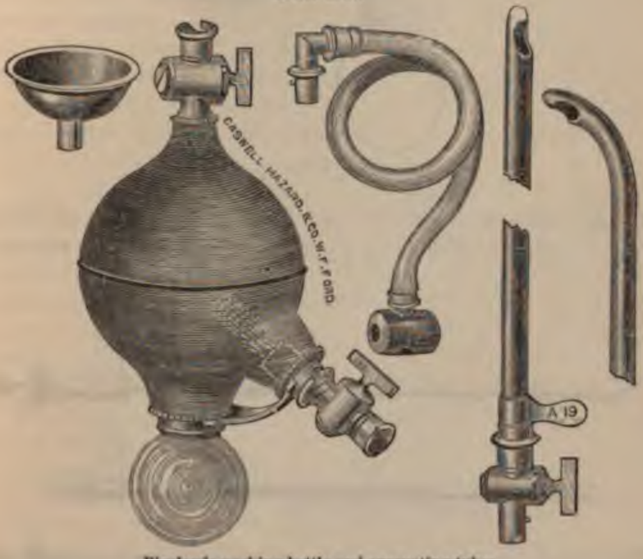
Except under ether, the crushing should not be repeated more than three or four times at one sitting, the lithotrite being retained in the bladder for from three to five minutes. In all the manipulations care must be taken not to bring the concavity of the jaws into contact with the sensitive neck of the bladder.

When the stone is lodged close behind a much enlarged prostate, the beak of the lithotrite must be completely reversed and the stone picked up, as it were.

The patient must be kept in bed for the twenty-four hours following the operation; and when he passes water he must roll well over upon his side without raising his shoulders from the bed.

Rapid Lithotrity with Evacuation. Litholapaxy (Bigelow).—The method of prolonged crushings under ether, with evacuation of the fragments, introduced by Prof. Bigelow in 1878, has completely superseded the old operation except for very small stones and in exceptional circumstances. The special instruments required, besides a lithotrite which can be trusted not to impact, are a washing bottle and straight or curved evacuating tubes. Of the former there are several patterns. Fig. 266 represents Prof. Bigelow's last model, and Fig. 267 Sir Henry Thompson's. The evacuating tubes should be of large size, say 28 to 30 of the French scale, with a very large eye, as shown in Fig. 266. The great practical difficulty in their use is that a large angular fragment may lodge in the eye so firmly that it cannot be

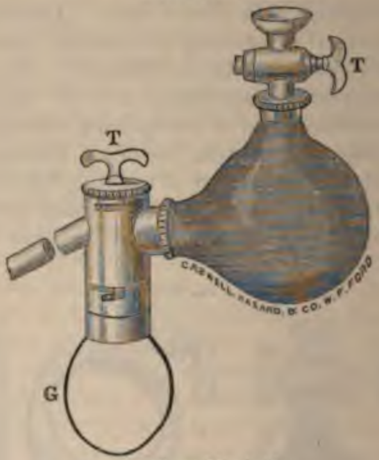
FIG. 266.



Bigelow's washing bottle and evacuating tubes.

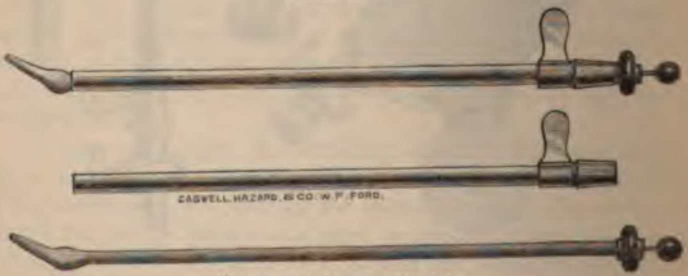
dislodged by the stream of water, and will tear the urethra as the tube is withdrawn. Prof. Keyes recommends a straight tube with an open end, cut square, and provided with a central staff having a curved rubber end that fills the orifice of the tube exactly and facilitates its introduction (Fig. 268). The limited use I have made of this tube has been very satisfactory.

FIG. 267.



Thompson's washing bottle.

FIG. 268.



Keyes's straight evacuating tube.

Anæsthesia must be employed. Recently in a few operations cocaine has been successfully used to prevent pain. Three or four drachms of the solution were thrown into the empty bladder and one into the urethra. The only pain felt was in the distention of the bladder in washing. The bladder is usually so sensitive to this distention beyond a certain limit that patients will manifest pain even when completely anæsthetized with ether, and I do not expect that cocaine will prove generally sufficient.

If the urine is turbid, and especially if it is ammoniacal, it should be drawn off before the operation, and the bladder thoroughly washed with a borax solution (one or two drachms to the pint), of which from two to four ounces should be left in the bladder to facilitate the crushing.

The stone is caught and crushed according to the directions already given, the crushings being rapidly repeated for several minutes. Then the smaller fragments are washed out, and the lithotrite reintroduced; and this alternation in the use of the instruments is continued until the bladder is emptied. This frequent washing is important because by the removal of the smaller fragments it is made easier to seize and crush the larger ones.

The washing is done as follows: The washing bottle is filled with tepid water, then the tube is introduced, and as soon as the urine begins to flow through it the bottle is coupled to it. Or the coupling may be done just before the tube has entered the bladder, and the air in the tube allowed to rise to the top of the bottle, by turning the stop-cock, before the introduction is completed and the washing is begun.

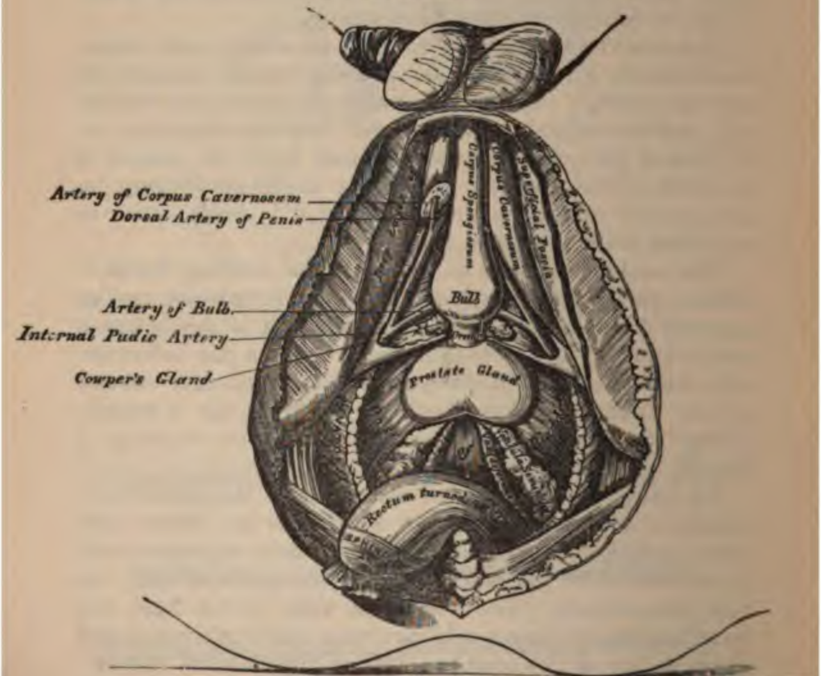
By quick compression and relaxation of the rubber bulb the water is rapidly forced into the bladder and drawn back again, bringing the fragments with it; these fragments sink to the bottom of the bottle and are not returned with the returning stream. The amount of water driven back and forth at each movement will vary with the sensitiveness and distensibility of the bladder; two or three ounces are sufficient to wash effectively. If the curved tube is used, its eye should be in turn directed to different quarters of the bladder; if the straight tube with a square end is used, it must be passed just through the neck, and its outer end well depressed between the thighs.

At the close of the operation the surgeon should place his ear upon the hypogastrium and listen while washing, to detect the click against the tube of any fragments that may remain. This is a much more delicate test than the use of the searcher.

LITHOTOMY.

The anatomy of the perineum is sufficiently well shown in Fig. 269 to render a detailed description unnecessary.

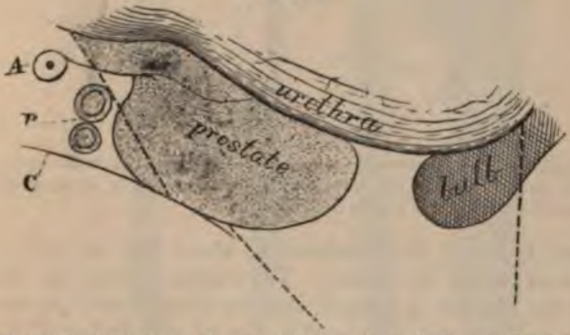
FIG. 269.



A view of the position of the viscera at the outlet of the pelvis.

It must be remembered, however, that the distance between the anus and the bulb diminishes with advancing years, and that the diminution of the distance is due to an increase in the size of the bulb. The dangers incident to incision of the bulb increase, therefore, with the difficulty of avoiding it. The dimensions of the prostate have been studied with much attention, and have been the basis of many of the modifications of perineal lithotomy, for it has been held, and still is held by many, that the incision should not be carried beyond the limits of the gland. The greatest radius, measuring from the urethra, is one inclined about 30° backward and downward from the transverse diameter, and in the normal adult prostate this measures about three-quarters of an inch at the largest part of the gland, that which adjoins the neck of the bladder. But, as the diameter of the prostate diminishes as the distance from the bladder increases, an incision which remains within its limits at one point may extend far beyond them at another; and this fact, taken in connection with the great variations in the size of the gland, indicates the futility of attempts to regulate the incision with mathematical precision. Fortunately, the depth of the incision is not a measure of the size of the stone which can be safely removed through it, for the normal dilatability of the neck of the bladder and the prostatic portion of the urethra (to a diameter of two centimetres, according to Dolbeau) is thought to be considerably increased by even slight incisions. Dupuytren thought the opening in the prostate could be greatly enlarged by making an

FIG. 270.

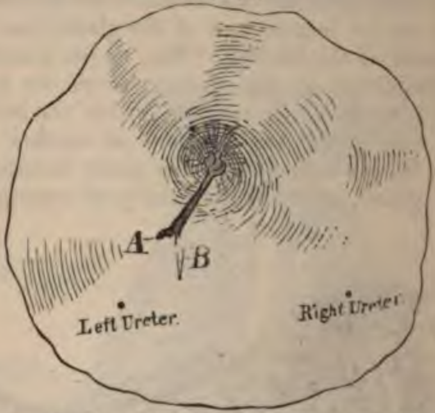


Incision in lateral lithotomy; the dotted lines mark its limits. *A.* Vas deferens. *B.* Seminal vesicle. C. Continuation of the capsule or prostato-peritoneal ligament.

oblique incision on each side (bilateral lithotomy), and an admirable instrument, the double lithotome caché (Fig. 287), was constructed for the purpose, but the gain has not proved so great as was expected.

By reference to Figs. 270 and 271, which show the extent of the incision of the prostate and neck of the bladder in lateral lithotomy, it will be seen that the limits of the prostate are exceeded everywhere, the capsule remaining intact, however, for a distance of about half an inch at the thickest part of the gland. The sulcus between the bladder and the prostate is opened, and the bladder wall divided for fully half an inch in the direction of the orifice of the left ureter. These figures are taken from a dissection of a cadaver upon which lateral lithotomy had been performed for the purpose of determining these points.[1]

FIG. 271.



Lateral lithotomy. Incision of the neck of the bladder as seen from within. *A* is a rent in the wall made by the introduction of the finger. *B* is an extension of the incision involving only the mucous membrane.

If the stone is large and the tractions made with too much force, the neck of the bladder may be torn off, but more commonly the incision is lengthened by tearing at its outer end, an accident which is much less dangerous than extending the incision with the knife would be, for it spares the rich plexus of veins about the prostate.

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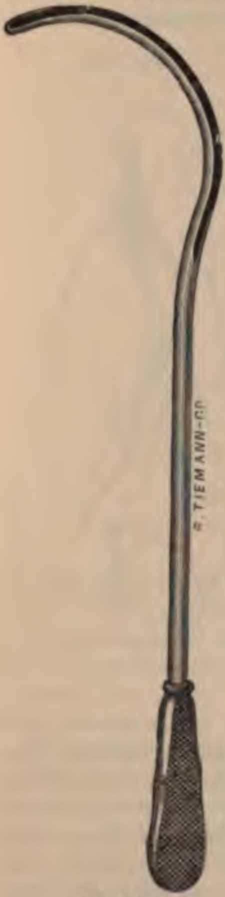
[1] The operation was done by a surgeon of large experience in lithotomy, and the incision was made as if for the removal of a stone one inch in diameter. The cadaver was that of a mulatto about twenty-five years old.

FIG. 272.



Lithotomy staff.

FIG. 273.

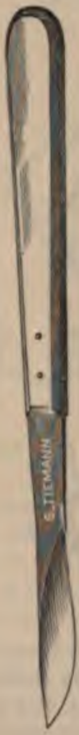


FIG. 274.

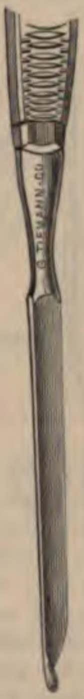
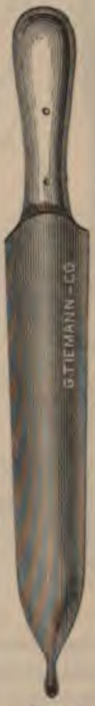
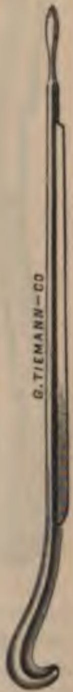


FIG. 275.



Gorget.

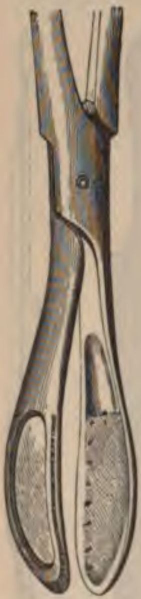
FIG. 276.



Scoop.

Lateral Lithotomy.—The instruments required are a staff with a long curve, deeply grooved on its convexity (Fig. 272), a stout scalpel with a cutting edge of one and one-half inches (Fig. 273), a Blizard's knife (Fig. 274), a blunt gorget (Fig. 275) if the patient is fat, a scoop (Fig. 276), forceps of different patterns (Figs. 277, 278, 279), a syringe and tube for washing out fragments, and a shirted canula (Fig. 280) to control hemorrhage. The latter can be readily made by passing the beak of a female silver catheter through the centre of a piece of muslin eight inches square, and tying the two firmly together, as shown in the figure. It is then introduced into the wound, the beak of the catheter in the bladder, the muslin pouch tightly packed afterwards with pledgets of lint, and the whole kept in place by a **T**-bandage. Three assistants, at least, are required; one to administer the anæsthetic, the others to hold the knees and the staff.

FIG. 277.



FIGS. 278, 279.

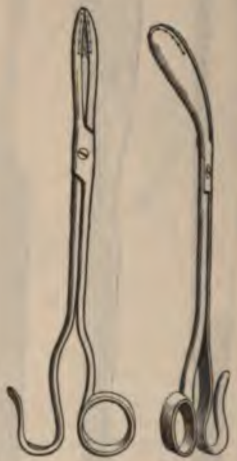
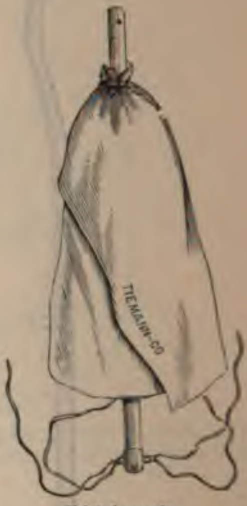


FIG. 280.



Shirted canula

Operation.[1]—The patient, having had his bowels emptied by an enema, is placed upon his back, his ankles bound fast to his wrists (Fig. 281), the staff introduced, and the stone touched with it. It is an absolute rule that if the stone cannot be felt with the staff or a searcher after the patient has been etherized and placed upon the table, the operation must be postponed. It is not necessary that the beak of the staff should rest upon the stone during the operation; on the contrary, it is better to hook the staff up under the symphysis so as to keep it steady, with its curve bellied out in the median line of the perineum, and the integument stretched over it by drawing the scrotum up around the staff.

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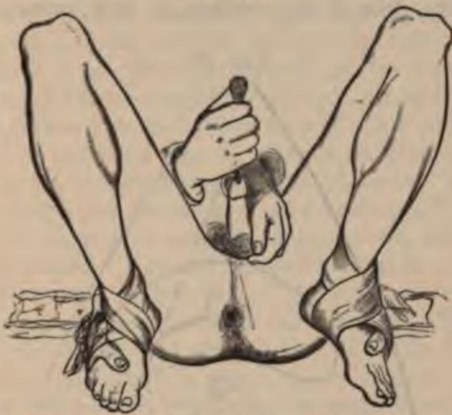
[1] Van Buren and Keyes, Genito-Urinary Diseases and Syphilis, p. 335.

FIG. 281.

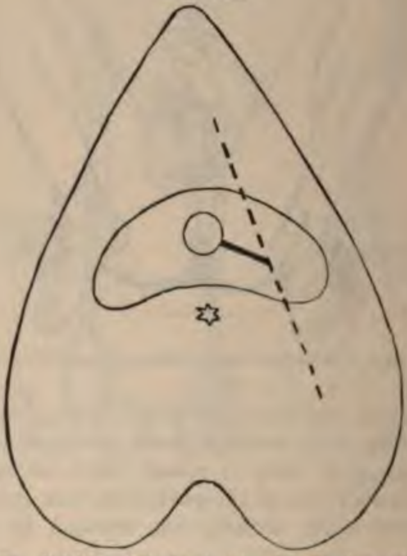


Position of patient and line of incision in lateral lithotomy.

The operator passes his index-finger into the rectum, and satisfies himself that the staff enters at the apex of the prostate and passes centrally through it, and that the rectum is empty. Then withdrawing his finger he feels along the raphe of the perineum for the groove in the staff, aiding himself, if necessary, by depressing and raising the handle several times.

Having found the groove he confides the staff to his chief assistant, enters the scalpel a little to the patient's left of the raphe, from one and one-quarter to one and one-half inches in front of the anus, and passes it in almost parallel to the rectum so as to enter the groove about half an inch in front of the apex of the prostate, guiding it, if he thinks best, by keeping his left index-finger upon the prostate in the rectum. (If the knife should be passed directly in to the nearest point on the staff, the bulb would be involved to an unnecessary extent.) As soon as the point of the knife has entered the groove, it is pushed along for half an inch, dividing the floor of the urethra to that extent, and then withdrawn, cutting steadily downward and outward so as to make a cutaneous incision about three inches long, passing midway between the anus and left tuber ischii.

FIG. 282.



Lateral lithotomy. Relations of the two incisions to each other and to the prostate. (Thompson.)

The probe-pointed Blizard's knife, guided upon the left index-finger, is passed into the groove, and the surgeon takes the handle of the staff from the assistant, depresses it somewhat, and pushes the knife along until its point is arrested at the termination of the groove at the end of the staff. Then depressing the handle of the knife, and bearing in mind the shape and position of the prostate, he makes an incision in it downward and outward at an angle of about 30° with the horizon (Fig. 282).

The index-finger is next introduced, the staff withdrawn, and the neck of the bladder gently dilated with the finger, or, if the perineum is deep and fat, with the blunt gorget carried in along the groove in the staff. If the stone is more than an inch in diameter, the Blizard's knife must be reintroduced, and the prostate cut upon its right side also.

The forceps are then introduced as the finger is withdrawn, and the stone sought for by opening and closing the blades at different points on the floor of the bladder; or the small end of the scoop may be introduced, placed in contact with the stone, and the forceps guided along it. If the stone is seized in a faulty direction, it must be dropped and caught again, or straightened with the fingers while still held between the blades. Extraction should be made slowly downward and outward in the line of the external incision, and aided by lateral movements of the handles. The old rule was that the force used should be two-thirds lateral, one-third extractive. If it is found that the stone is too large to be removed without employing too much force, it must be crushed, and the fragments removed separately. Small stones and fragments are best removed with the scoop and by thorough washing.

In operating upon children certain modifications are required. The prostate being very small the incision usually passes quite beyond its limits, but this is a matter of slight importance since the ill results which follow in adults and old men do not occur at this age. If the incision in the urethra and at the neck of the bladder is not sufficiently free, it may happen that, in the attempt to introduce the finger, the urethra will be torn entirely across and the bladder pushed up before it. Again, the bladder is placed higher in the child than it is in the adult, and therefore the point of the knife must be more raised in making the deep incision, and care must be taken not to let it slip in between the rectum and bladder. Mr. Erichsen[1] says he has known this to occur in several instances, and the forceps to be passed into this space under the impression that it was the bladder.

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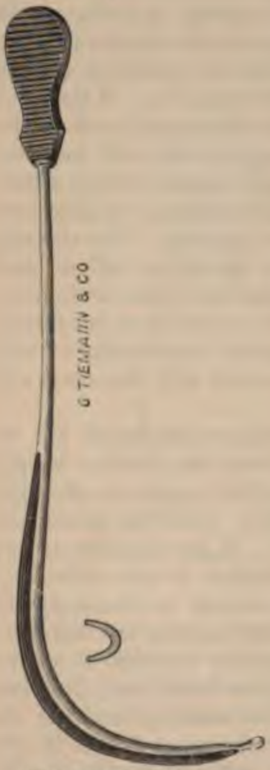
[1] Science and Art of Surgery, vol. ii. p. 682, Phila., 1873.

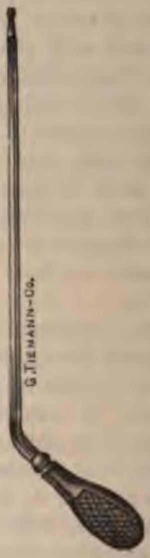
It has also happened to some surgeons to force the beak of the staff through the roof of the urethra into the space between the bladder and posterior face of the pubes, and to be so deceived by its freedom of motion in the loose cellular tissue of that region that they thought it was in the bladder, and cut upon it accordingly.

FIG. 283.



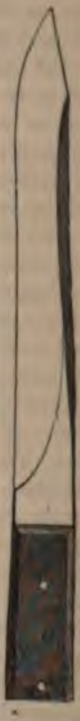
Staff for median lithotomy.

FIG. 284



Ball-pointed director.

FIG. 285.

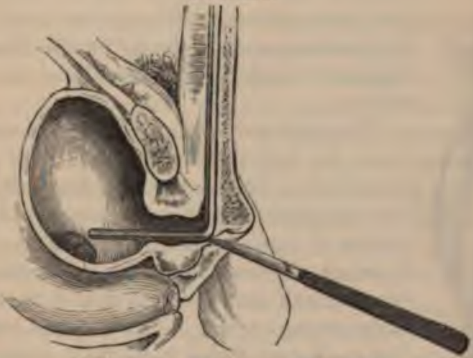


Double-edged scalpel.

Median Lithotomy.—The only instruments required other than those used in the lateral operation are a staff, director, and knife. The staff has a central, broad, deep groove on its convexity (Fig. 283), the director has a ball-point (Fig. 284), and the knife is straight, stout, and sharp pointed, with a cutting edge upon the back also for a short distance from the point (Fig. 285).

The patient having been bound in the lithotomy position and the staff introduced, the surgeon places his left index finger in the rectum against the apex of the prostate, and plunges the knife with its edge upward into the raphe of the perineum half an inch in front of the anus in such a direction that its point will enter the groove of the staff just at the apex of the prostate. The knife is pushed very slightly back along the groove so as certainly to open the urethra and nick the end of the prostate, then brought forward, dividing the membranous portion of the urethra, and swept around the bulb by raising the handle, making an external incision upward along the raphe for about one and a quarter inches. The director is next passed along the staff into the bladder, the two separated angularly to make partial dilatation of the neck, the staff withdrawn, and the dilatation completed with the finger. The forceps are then introduced and the stone removed as in lateral lithotomy.

FIG. 286.

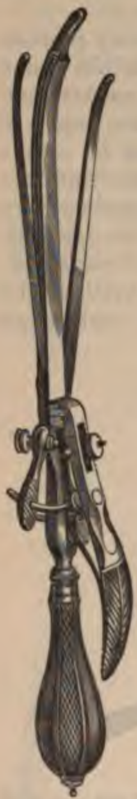


Median lithotomy with rectangular staff.

Sir Henry Thompson makes the incision from without inward, and Mr. Erichsen uses a rectangular staff (Fig. 286), placing its angle close against the apex of the prostate.

Bilateral Lithotomy (Dupuytren).—The characteristic of this operation is the bilateral incision of the prostate, accomplished by means of Dupuytren's double lithotome caché (Fig. 287). The preliminary part of the operation, including the incision into the urethra, may be the same as in median lithotomy, but the advantage of less risk of hemorrhage which this presents is more than offset by the lack of correspondence in form and direction between the incision in the prostate and that in the perineum, and the greater risk of infiltration of urine which this involves.

FIG. 287.



Dupuytren's double lithotome caché.

The double lithotome caché is an instrument composed of a flattened, slightly curved, metallic sheath, blunt-pointed, and mounted on a stout handle. Within this sheath are two blades of the same shape and sharp on their concave borders, which can be made to project, one on each side, as shown in Fig. 287, by pressing upon a lever in the handle; the degree of projection is regulated at will by a screw.

The patient is placed in the lithotomy position, the staff introduced and held as before described. The surgeon draws the skin of the perineum tight with his left hand, and makes a curved incision beginning midway between the anus and the right tuber ischii, passing half an inch in front of the anus, and terminating on the left at a point corresponding to that at which it began. The skin, subcutaneous tissue, and anterior fibres of the sphincter ani are divided along the line of the incision, and the bulb drawn forward if encountered; the left index-finger is then introduced into the wound, the groove in the staff found, and the membranous portion of the urethra divided for a distance of about half an inch from behind forward. The lithotome is next introduced closed, its concavity upward, and its point engaged in the groove and passed along the bladder. The staff is then withdrawn, the lithotome reversed so as to turn its concavity downward, its blades opened to the full extent previously determined upon, and the instrument slowly withdrawn. This part of the operation must be conducted with great care; the surgeon grasps the lithotome with both hands, holds it steadily in the median line, and depresses the handle gradually as the instrument comes out. As soon as the resistance is felt to have been overcome he closes the blades and withdraws the lithotome entirely. The forceps are then introduced and the stone removed as before.

Pre-rectal Lithotomy (Nélaton).—The bilateral operation gives a large opening, but exposes to the risk of cutting into the rectum or into the bulb; Nélaton, therefore, modified the first stage with a view to diminishing these risks, giving to his modification the name of pre-rectal lithotomy. The instruments used are the same as in the bilateral operation.

The patient is placed in the lithotomy position and the staff introduced. The surgeon passes his left index-finger into the rectum and places it against the apex of the prostate. Then, steadying the anterior margin of the anus with the thumb of the same hand, he makes a curved incision beginning two centimetres from the anus on the right side, crossing the median line of the perineum one and a half centimetres in front of it, and ending on the left side at a point corresponding to that at which it began. Or, if it is wished to make it more precisely, make a transverse incision three centimetres long, its centre resting upon the median line one and a half centimetres in front of the anus, and then from each end of this line make one obliquely downward and outward to a point two centimetres from the lateral margin of the anus. The posterior lip of the incision is drawn down by the thumb, stretching the anterior fibres of the sphincter, and thus making it easier to divide them. This division must be made very carefully layer by layer, using the sponge constantly, and if necessary a vertical incision may be made through the skin along the raphe to give more room. When the division is complete the anterior wall of the rectum can be easily pressed downward, and the membranous portion of the urethra and the prostate felt at the bottom of the wound. The knife, a long narrow one, is then entered with its back toward the rectum, its point passed into the groove of the staff at the apex of the prostate, and the urethra divided longitudinally for half an inch from behind forward, by depressing the handle of the knife and pressing its point forward with the finger placed against its back.

The double lithotome is then entered and the prostate incised as in the bilateral operation.

Recto-vesical Lithotomy.—This operation has been almost entirely abandoned, and therefore only a brief description will be given. The original plan was to divide the sphincter and anterior wall of the rectum, and then the posterior portion of the prostate and the adjoining wall of the bladder in the median line, guiding upon the groove of the staff. More recently, however, Theodore Schaeffer[1] has proposed another method. He dilates the bladder by injecting air or carbonic acid gas, then introduces a Sims's speculum into the rectum, pinches up a transverse fold of the rectal mucous membrane above the base of the prostate with forceps, transfixes and cuts through it. He next divides the prostato-peritoneal aponeurosis longitudinally, and the wall of the bladder in the same line with scissors, after passing the point of one of the blades through into the groove of the staff previously introduced into the bladder through the urethra.

Supra-pubic Lithotomy and Cystotomy.—This operation has of late come into greater favor for the removal of large stones and of tumors of the bladder, and a great improvement in the method of its performance has been made by Petersen in the elevation of the bladder by the inflation of a large rubber bag introduced into the rectum.

The interior of the bladder is cleaned by washing with an antiseptic solution, and the organ distended by an injection until, if possible, it rises well above the pubes. Some surgeons make the injection through a curved metal catheter and tie it in by a rubber cord wound about the penis, to serve later as a guide in opening the bladder. Then the rectal bag, having a capacity of about a pint, is introduced and distended, and an incision made in the median line close above the pubes, and carried down layer by layer until the bladder is reached. The distention of the bladder raises the reflection of the peritoneum well above the pubes, so that, with care, there is no danger of its being divided. Then, with curved needles, a stout ligature is fixed in the wall of the bladder on each side of the median line, and the wall divided between them with a sharp-pointed knife from above downward.

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[1] Quoted by Dubrueil, Médecine Opératoire, p. 815.

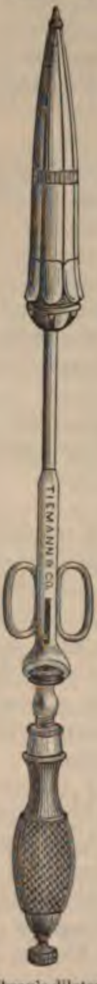
The proper subsequent treatment is still in dispute. Some close the wound in the bladder with sutures passed through its wall, but not through its mucous membrane, and drain away the urine by a catheter kept in the urethra. Others, and this seems to me to be the more prudent plan, close the bladder wound only in part and drain its cavity through a long rubber tube introduced through the wound. The external wound should, in either case, be (partly) closed and drained.

If more room is needed during the operation the insertions of the muscles on the pubes on each side of the incision may be divided.

Perineal Lithotrity (Dolbeau).—By this operation access to the bladder through the perineum is obtained by means of a small incision through the skin and urethra, together with dilatation of the neck of the bladder, so that a lithotrite can be introduced of sufficient size and strength to crush the stone and effect its removal at a single sitting. The special instruments required are the *dilator*, one of which is represented in Fig. 288, and a strong lithotrite, if the stone is too hard to be crushed by forceps.

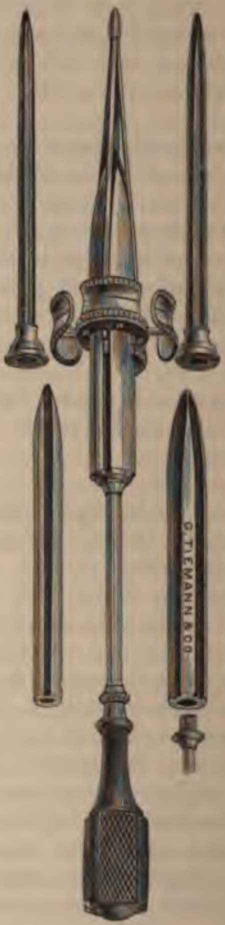
The patient is placed in the lithotomy position, and a grooved staff introduced and held vertically in the median line. The surgeon, beginning close to the margin of the anus, makes an incision not more than one inch in length along the raphe of the perineum; he divides the tissues layer by layer until he reaches the membranous portion of the urethra, and incises it longitudinally for one-quarter of an inch. He then passes the dilator into the wound, engages its point in the groove of the staff, holds it steadily at right angles to the plane of the perineum, and dilates it to the full extent. Next, closing the dilator and keeping its point in

FIG. 288.



Dolbeau's dilator.

FIG. 289.



Guyon-Duplay dilator.

the groove, he depresses the handle of the staff 40° or 50° beyond the vertical line in which it has been held, and at the same time slips the dilator along nearer to the neck of the bladder. He again dilates, closes the instrument, passes it fairly into the bladder, withdraws the staff, and dilates for the third time. This time the dilatation must not be carried beyond a diameter of two centimetres, in order to avoid tearing the neck of the bladder. Finally, the dilator is closed and withdrawn.

Guyon and Duplay use the dilator shown in Fig. 289, introducing it at once into the bladder, withdrawing the staff, and dilating by introducing successively the different centre pieces.

The stone, if not more than one centimetre in diameter, may be removed entire, but in the great majority of cases it should first be crushed by means of strong forceps or a lithotrite, and then removed in fragments. Duplay guides the forceps upon his finger; Dolbeau insists that the finger should never be introduced, since it is large enough to tear the neck of the bladder.

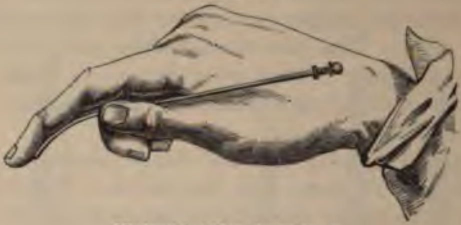
CHAPTER VIII.

OPERATIONS UPON THE GENITO-URINARY ORGANS OF THE FEMALE.

CATHETERIZATION.

THE surgeon, standing on the right side of the patient and holding the catheter in his right hand, with its convexity lying on the palmar surface of the index-finger and its beak not quite reaching to the end of the distal phalanx (Fig. 290), separates the nymphæ with the thumb and middle finger of his left hand, introduces his right index-finger at the fourchette and brings it forward, recognizing the entrance to the vagina and its anterior border, and stopping when he feels the pouting orifice of the urethra. Then keeping the pulp of the finger below and in contact with the orifice he passes the catheter in.

FIG. 290.



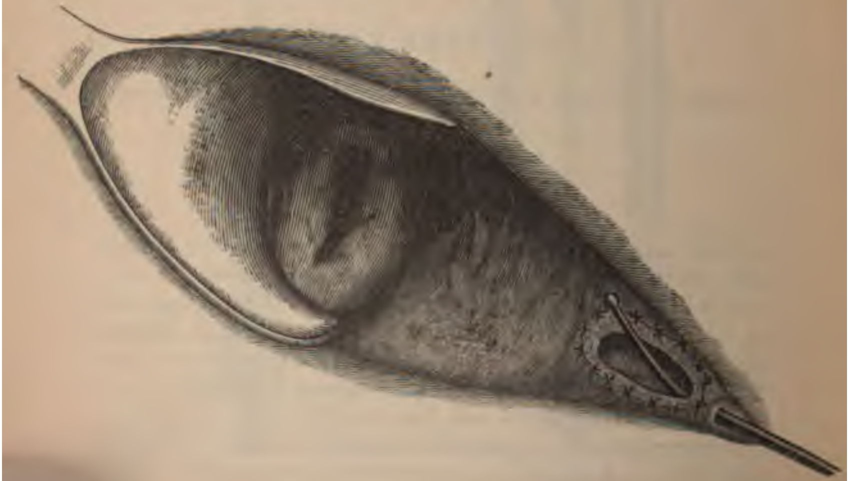
Mode of holding the catheter.

Unless there is some reason to the contrary, this should always be done without exposure of the parts.

EXTERNAL URETHROTOMY.

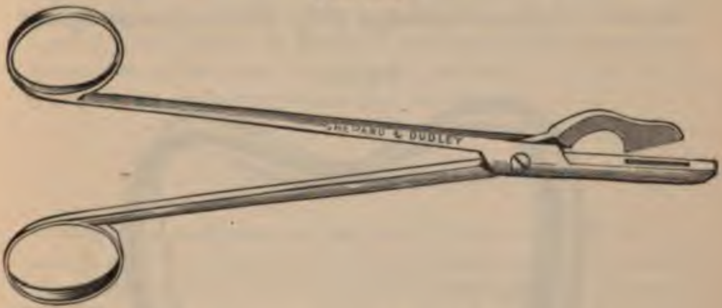
The Buttonhole Operation (Emmet) (Fig. 291).—The patient is anæsthetized and placed on the left side, and the

FIG. 291.



fourchette retracted with a small Sims's speculum. A full-sized metal sound is introduced into the urethra, then the tissues in the vaginal surface are caught up with a tenaculum and divided longitudinally midway between the meatus and the neck of the bladder. The incision may then be extended with scissors. Neither the neck of the bladder nor the meatus should be divided. If the incision is to be kept open, the urethral mucous membrane must be drawn out through it and stitched with catgut to the edge of the divided vaginal surface. The incision may be conveniently made with Emmet's buttonhole scissors (Fig. 292).

FIG. 292.



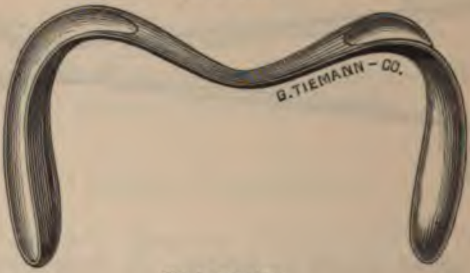
LITHOTOMY.

Besides the *supra-pubic*, which is performed in the manner already described, there are the *urethral* and *vesico-vaginal* operations. In the former the stone is removed through the urethra after the calibre of this canal has been increased by an incision along its anterior (upper) wall, or on one or both sides, incisions which do not extend into the vagina. In the latter the stone is removed through an incision made in the vesico-vaginal septum.

Urethral Lithotomy.—The only instruments actually required are a director, a probe-pointed knife, and forceps, but some surgeons prefer to make the incision with a single or double lithotome introduced alone or upon a director. Lateral incisions should incline upward rather than downward; consequently, if the double lithotome is used, its concavity should be turned toward the symphysis. The extraction of the stone requires no additional description.

Vesico-vaginal Lithotomy.—The patient may be placed in the usual lithotomy position, or upon the side, or upon the face. A Sims's speculum (Fig. 293) is pressed against the posterior wall of the vagina, and a grooved catheter introduced into the bladder and confided to an assistant, who keeps it pressed well against the vesico-vaginal septum.

FIG. 293.



Sims's speculum.

Guiding his knife upon the groove the surgeon makes an antero-posterior incision in the median line of the anterior wall of the vagina, about one inch in length, and not involving the neck of the bladder, passes in his index-finger, and then the forceps upon the finger as a guide.

Emmet places no sutures, but allows the wound to close spontaneously, keeping the bladder clean by frequent washings. Guyon closes the incision immediately with sutures.

In a recent discussion in the Société de Chirurgie[1] the fact was brought out that lithotomy and lithotrity upon the female are more dangerous operations than they are usually said to be. The fatal complications are of two kinds: peritonitis in patients who have previously been affected by it; and pyæmia, originating in inflammation of the spongiovascular tissue constituting part of the vesico-vaginal septum. Speaking generally, it may be said that lithotrity[1] is more dangerous in the female than lithotomy, that the supra-pubic operation should be used for large calculi, dilatation of the urethra for small ones, and, with crushing, for large friable ones when the inflammation is not high and there has been no previous peritonitis; urethral or vesico-vaginal lithotomy in other cases. As to the comparative merits of urethral and vesico-vaginal lithotomy opinions are divided; the former is followed occasionally by permanent incontinence, the latter by fistula; probably, too, the latter is somewhat more dangerous than the former.

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[1] Bull. de la Société de Chirurgie, 1877, pp. 182 and 400.

OCCLUSION, OR ATRESIA VAGINÆ.

When the occlusion is due simply to an imperforate hymen it may be relieved by successive punctures with a small trocar or aspirator, and when all the accumulated menstrual blood has been thus removed, and the cavity well washed out with a two or three per cent. solution of carbolic acid, the hymen may be excised, or a large puncture made, and kept open by frequently passing a sound. It must be remembered that very serious complications, such as peritonitis and septic poisoning, may follow this simple operation when there has been a large accumulation of menstrual blood above the obstruction.

When, on the other hand, the occlusion is due to incomplete development of the vagina, a more systematic operation is required. The surgeon first assures himself by digital examination through the rectum of the existence of the uterus, then places the patient upon her back with her thighs flexed and abducted, and introduces a sound into the bladder and confides it to an assistant. He next passes his left index-finger into the rectum, makes a transverse incision across the centre of the obliteration, and carries it in the direction of the uterus by successive short cuts with the knife, or by tearing with a director or his fingers, guiding his course by the sound in the bladder and the finger in the rectum. As soon as fluctuation can be felt in front of the uterus he punctures with a trocar and enlarges the puncture with a probe-pointed bistoury.

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[1] In this remark reference is made to the old operation of lithotrity. The few cases of litholapaxy in the female of which I have knowledge have been successful.

PERINEORAPHY.

Dr. Emmet[1] has recently shown that the lesion heretofore known as "partial rupture of the perineum," and supposed to be a laceration along the posterior median line of the tissues at the lower part of the vagina and the perineum, is actually a transverse rent at or within the ostium vaginæ, which, by the dropping and eversion of the lower lip of the wound, is made to present the appearance of a longitudinal one. He has also recently recognized and described a variety of this lesion in which the laceration is submucous, in which the muscular and fascial diaphragm, constituted in part by the sphincters and closing the outlet of the pelvis, is torn away from the supporting fasciæ and muscles which run upward to attach its centre to the inner side of the bony pelvis, and, having thus lost its support, allows the posterior part of the vulva to be everted, with production of a rectocele by protrusion of the rectum through the (subcutaneous) gap. To this latter condition he gives the name *prolapse of the posterior wall of the vagina.* The two conditions, the subcutaneous and the complete rents, are essentially the same, and require nearly the same denudation of the surface. The aim of the operator in either case is to lift up the depressed and everted lower lip, unite its edge to that of the mucous membrane of the vagina at the crest of the rectocele, and thus cover in the latter and renew its anterior support.

Laceration of the vulvar orifice in the posterior median line may occur without coexistence of the above described lesion, beginning at the fourchette and extending backward, but such laceration is unimportant because it involves only parts that lie outside the real support of the viscera.

A third form is the important one in which laceration of the sphincter ani in the median line takes place. In noninstrumental delivery this begins as a longitudinal slit in the recto-vaginal septum and extends from within outward and forward. When caused by the forceps it begins at the fourchette and extends backward. To this form Dr. Emmet limits the term *rupture of the perineum.*

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[1] Principles and Practice of Gynecology, 1884, p. 364.

Accepting this classification, I shall describe the operation for, 1st, Prolapse of the posterior wall of the vagina,—two varieties, with and without laceration of the mucous membrane of the vagina; and, 2d, Rupture of the Perineum (and the sphincter ani).

FIG. 294. FIG. 295. FIG. 296. FIG. 297.

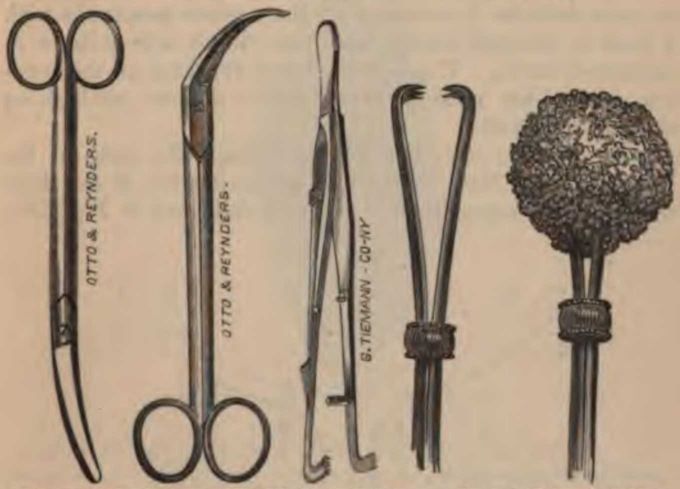


Fig. 294. Curved scissors. Fig. 295. Emmet's scissors. Fig. 296. Thomas's toothed forceps. Fig. 297. Sponge-holder.

Prolapse of the Posterior Wall of the Vagina. (1st variety, without surface laceration.) *Operation.*—Thighs flexed on abdomen and supported under the arm of an assistant on each side, who also draw aside the labia and hold the tenacula during the act of denudation. The operator seizes with a tenaculum the mucous membrane of the vagina at the crest of the rectocele in the median line at a point which can be drawn down to the urethral orifice by gentle traction, and, having thus drawn it down, has it held in place by the assistant. Then, with two other tenacula, he hooks up the lowest caruncle, or vestige of the hymen, on each side, and draws them upward and outward to the first tenaculum. This movement creates an inverted, crescentic, transverse fold within the vagina just below the first tenaculum, its horns shading gradually into the sulcus on each side, and a shallow longitudinal fold in the median line between the last two tenacula. The opposed surfaces of these folds constitute the area to be denuded.

Dropping one lateral tenaculum, he gives the other to an assistant who draws it gently outward to define by this traction the limits of the denudation on that side, and then the surgeon denudes by catching up the mucous membrane with a hook or pronged forceps and removing it with scissors in successive strips. The process is then repeated on the opposite side. Care must be taken not to denude too high on the posterior wall.

Silver sutures are then passed to unite the parts in the positions given them by the first approximation of the three tenacula, producing the line of union indicated in Fig. 298.

FIG. 298.

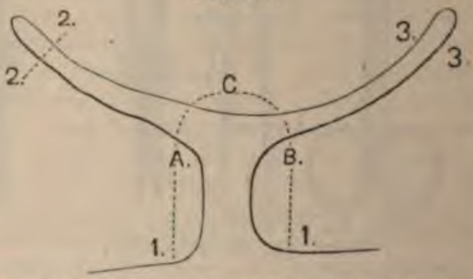
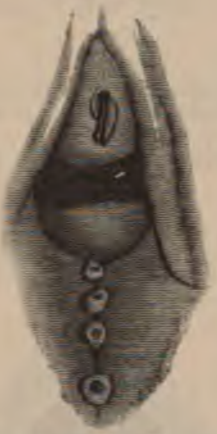


Diagram showing the line of union and direction of the sutures.

The sutures of the crescentic part should be of silver wire; those of the central line may be of silver, silk, or catgut. A final silver suture should be passed through the labium near the caruncle on one side, across to the posterior wall of the vagina, under its mucous membrane for nearly an inch just above the edge of the denudation, and then through the other labium at a point opposite to that at which it began.

In passing the sutures a thick, straight, sewing needle armed with silk should be used, and the tissues to be traversed by it should be pressed forward by the finger in the rectum. The sutures should not be buried throughout their course, but should cross the fold midway between its free edge and its bottom. The silver wire is drawn through in the loop of the silk. The appearance, when the operation is completed, is shown in Fig. 299, the crescentic part being hidden within the vagina.

FIG. 299.



Appearance at completion of the operation.

2d Variety. Prolapse with Surface Laceration.—The position of the patient is the same as in the preceding form, and the area of denudation is determined in like manner; speaking generally, it must extend downward to the line of junction between the skin and the cicatricial mucous membrane. Its shape, when spread out, is that of a trefoil (Fig. 300). The sutures are passed in order from below upward, and none tightened till all are in place. The lower ones are buried throughout their course; the upper ones are partly exposed on each side, as shown in Fig. 301. The suture marked *D* includes about an inch of the recto-vaginal septum; the uppermost suture, *C*, passes through the mucous membrane of the septum above the denudation, and when tightened draws it down like a hood to protect the approximated edges, and also sustains all the traction while the opposed denuded surfaces are uniting.

FIG. 300.

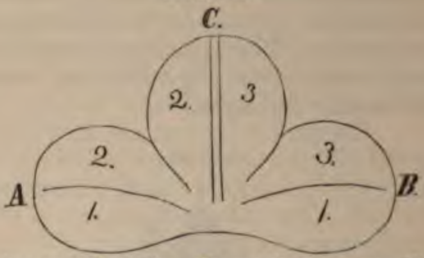
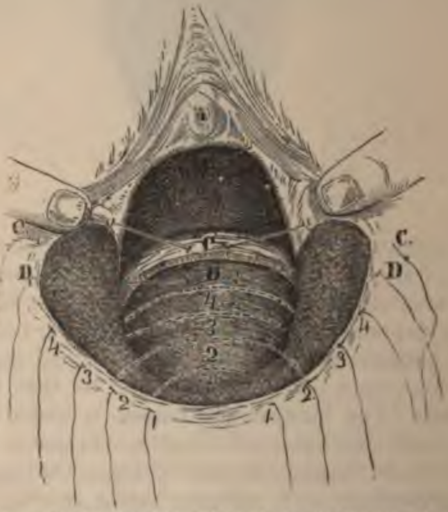


Diagram showing area of denudation. The parts bearing corresponding figures are brought into apposition by the sutures.

Dr. Emmet leaves the sutures in place for about three weeks.

FIG. 301.



Emmet's operation for diminishing the vaginal outlet by external sutures.

Laceration of the Perineum, including the Sphincter Ani.—If the anterior wall of the rectum is ruptured for more than one or one and a half inches above the upper margin of the sphincter, Dr. Thomas prefers to close it by a preliminary operation, leaving the restoration of the perineum for a subsequent one. Dr. T. Addis Emmet was the first to show why it is not sufficient simply to close the gap between the vagina and rectum, and to demonstrate the need of bringing the ends of the severed sphincter into close contact with each other, and with the end of the recto-vaginal septum.

Let Fig. 302 represent the perfect sphincter, and Fig. 303 the sphincter ruptured and spread out with the points of entrance and exit of needle *AA*, the dotted line showing the course of the suture, including the end of the recto-vaginal wall *C*. As the suture is twisted, the three points are brought nearer together, as in Fig. 304, until they finally unite, as in Fig. 305. If the first needle is passed in and out at *BB*, complete union of the ends of the muscle will not be obtained, and loss of function will persist. The first suture is the important one, and must bring the torn

FIG. 302.

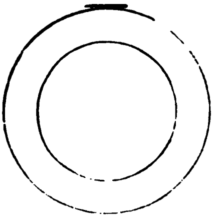


FIG. 303.

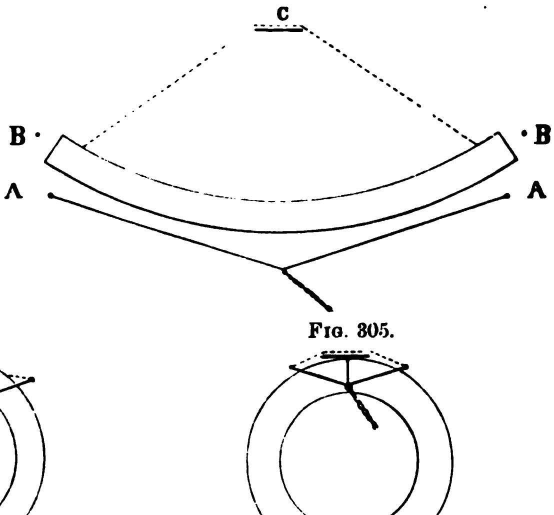


FIG. 304.

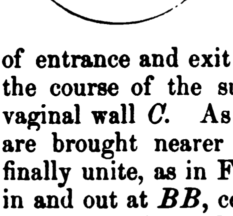
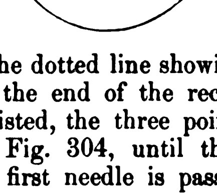


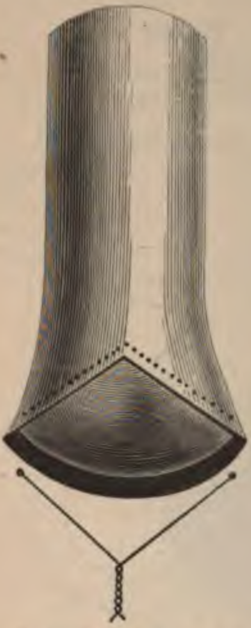
FIG. 305.



ends of the muscle into contact with each other and with the end of the septum.

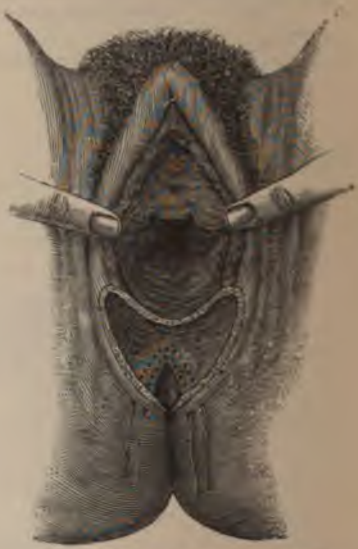
In freshening the parts before passing the needles, the two lateral triangles, forming the ruptured surface of the body of the perineum, are denuded, and the line of denudation is prolonged backward along the edge of the recto-vaginal septum. This denudation must extend along the edge of the mucous membrane of the rectum, but not include it. Fig. 306 is a schematic representation of the end of the ruptured bowel, the points of entrance and emergence of the needle, and the course of the first suture.

FIG. 306.



Ruptured sphincter. First suture.

FIG. 307.

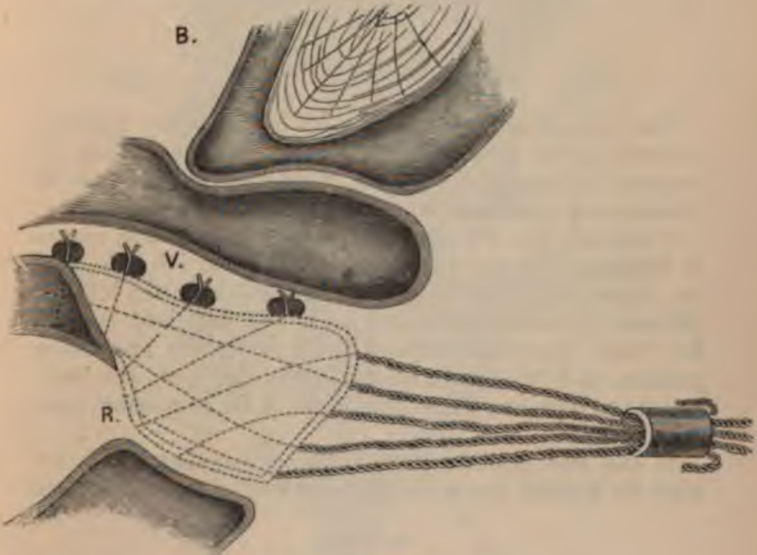


Complete perineal rupture. First and second sutures in place.

The rule for passing the first suture, then, is, to enter the needle as low down as the lower edge of the anus, pass it thence upward through the recto-vaginal septum, completely encircling the rent, and bring it out alongside the lower edge of the anus on the other side. Its action, then, is like that of a purse string, it puckers up the open parts, controls the action of the sphincter, and guards against the two principal sources of failure, recto-vaginal fistula and non-union of the sphincter (Fig. 307).

Dr. Emmet now recommends that this injury should be treated as if it were "a recto-vaginal fistula in the median line, with the sides easily approximated." (Loc. cit., p. 401.)

FIG. 308.



Half section through the pubes.

The denudation is done with scissors, beginning at the outlet and near the rectal surface, and continuing from below upward, so as to avoid the flow of blood over the surface yet to be freshened. Since the sides of the tear, after retraction, are not sufficiently broad to give a good surface for union, a portion of the adjoining vaginal mucous membrane must be removed, and the angle must also be extended on the vaginal surface for half an inch or more beyond the rectal edge. Then, beginning at the angle, several transverse, interrupted silver sutures are passed from the vaginal edge on one side, under the denuded surface, across the gap, and under the opposite denuded surface to the opposite vaginal edge, and two or three additional sutures are passed by the old method, that is, beginning in the skin near the lower edge of the anus, continuing up through the tissues alongside the rent, through the septum, and down on the other side, so as completely to include the rent. Fig. 308 shows these different sutures. The last two mentioned are the 2d and 4th in the figure, counting from below upward.

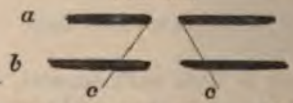
VESICO-VAGINAL FISTULA.

The patient is prepared for the operation by measures directed to the improvement of her general condition, by regularly syringing the vagina with warm water, and by dividing any cicatricial bands that may have formed in it.

Position.—Dr. Thomas recommends the position known as Sims's. The patient is placed upon the left side, with the thighs flexed, the right rather more so than the left, the left arm is drawn behind her back, and her chest brought flat down upon the table. Others prefer the knee-elbow position, and Simon placed the patient flat upon her back, raised the hips, and flexed the thighs as far as possible upon the abdomen.

If the first position is employed, an assistant stands behind the patient, draws the posterior wall of the vagina back by means of a broad Sims's speculum held in his right hand, while with his left he raises the right side of the nates.

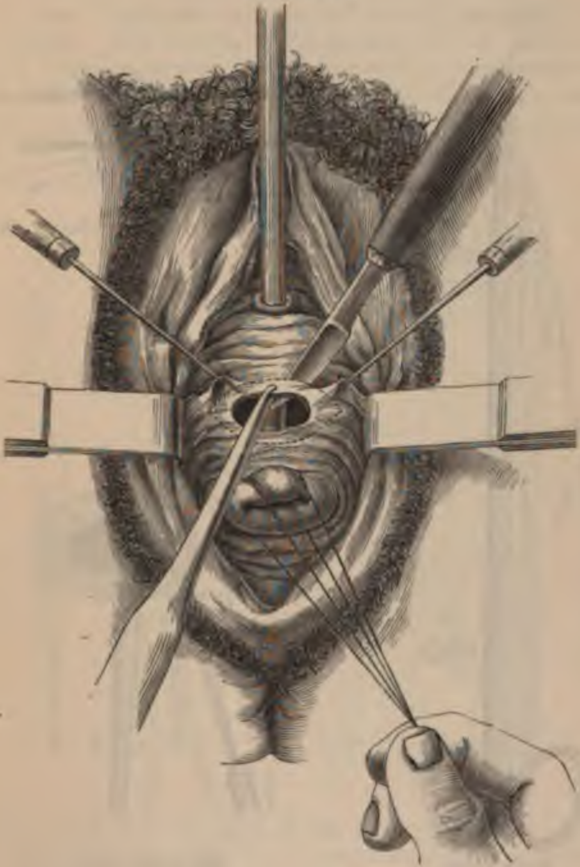
FIG. 309.



a. Vesical surface. b. Vaginal surface. cc. Line of paring.

The surgeon then pinches up, with toothed forceps or a tenaculum, the vaginal edge of the fistula at the point most difficult of access, and cuts off a piece including in breadth all between the vesical edge of the fistula and a point in the vagina at least one-third of an inch from the vaginal edge of the fistula. The cutting may be done with curved scissors

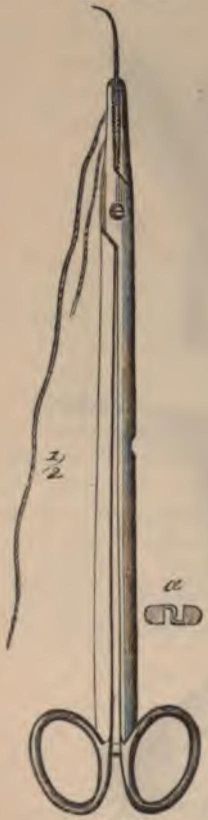
FIG. 310.



Drawing down the uterus to facilitate the paring.

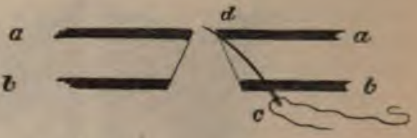
or a narrow-bladed knife. Successive portions of the edge are raised and removed in like manner, until the denudation is complete, the resulting raw surface being funnel-shaped, with its narrowest part at the edge of the vesical mucous membrane, the membrane itself not being included in it (Fig. 309). Or the point of the knife may be entered into the mucous membrane of the vagina one-third of an inch from the edge of the fistula, brought out at the vesical border, and then carried right and left around the opening so as to cut off a complete ring of tissue.

FIG. 311.



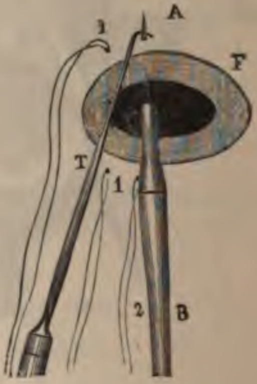
Needle holder.

FIG. 312.



a. Vesical surface b. Vaginal surface. c. Needle.

FIG. 313.



Passing the needle.

If the anterior wall of the vagina is freely movable, Simon brings the fistula into plain view by passing a stout ligature through the cervix of the uterus, and drawing it down toward the vulva (Fig. 310). He also pares the edges of the fistula very freely, and does not hesitate to include the mucous membrane of the bladder in the incision.

As soon as the hemorrhage has ceased, the sutures may be passed. The needle, three-quarters of an inch long, round, slightly curved, and armed with a fine double silk suture, is fixed in a needle holder (Fig. 311), and entered at the angle of the wound which is most difficult of access, half an inch from the edge of the raw surface, and its point brought out at the edge of the vesical mucous membrane, but not including it (Fig. 312), and there fixed with a blunt hook (Fig. 316), until it can be seized and drawn through with the needle forceps. It is then entered at the corresponding point on the opposite side, and brought out on the vaginal surface half an inch from the edge of the opening

FIGS. 314, 315, 316.

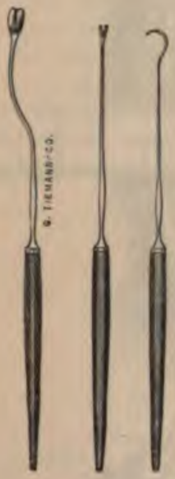
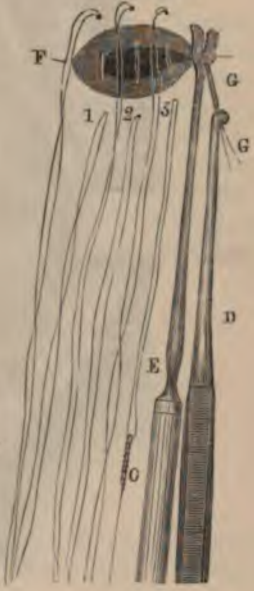
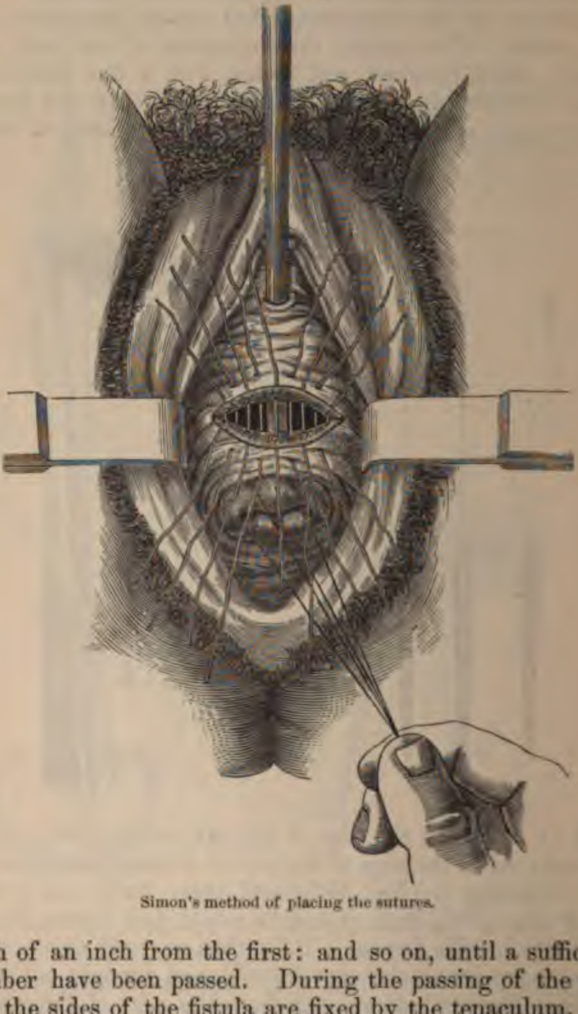


FIG. 317.



(Fig. 313). The ends of the ligature are given into the charge of the assistant who holds the speculum, and another needle is passed in the same manner at the distance of one-sixth of an inch from the first: and so on, until a sufficient number have been passed. During the passing of the needles the sides of the fistula are fixed by the tenaculum.

FIG. 318.



Simon's method of placing the sutures.

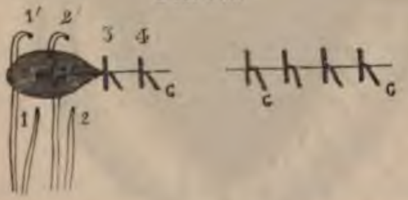
When the needle is seized with forceps and pulled through, counter-pressure must be made upon the tissues, and this is best done by means of the split rod or fork, represented in Fig. 315, its prongs passing on either side of the needle.

After all the ligatures have been passed, a silver wire, about twelve inches long, is fastened to the loop of the first ligature (Fig. 317, *C*), and drawn through with the help of the fork. The silk is cut off, the ends of the wire drawn aside out of the way, and the others passed in the same manner.

Simon used fine silk sutures (two rows when the fistula was large), tied in the ordinary manner, and often passing through the vesical mucous membrane (Fig. 318).

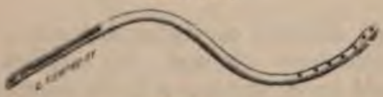
The ends of the silver sutures being drawn together, and the edges of the wound carefully approximated, each thread is slightly twisted so as to keep the parts in apposition, and then the ends of the first are seized with forceps and twisted with the help of the shield (Fig. 314), as shown in Fig. 317; care being taken not to twist so tightly as to strangulate the tissues engaged in the loop. The other sutures are then twisted in the same manner, and the ends of each cut off about half an inch from the surface (Fig. 319).

FIG. 319.



The bladder is then syringed to remove any blood that may have collected in it, and a Sims's catheter (Fig. 320) passed into it and left there.

FIG. 320.

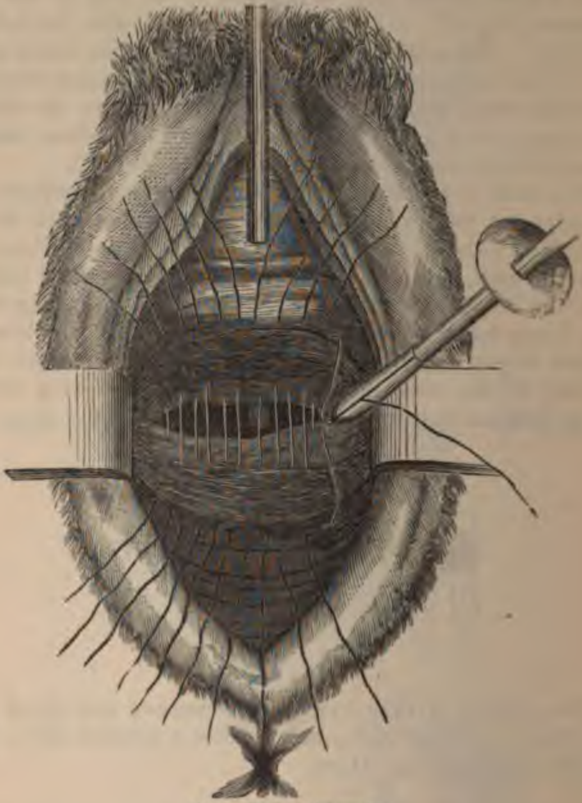


Sims's catheter.

The sutures may be removed during the second week.

Creation of a Vesico-Vaginal Fistula.—This operation is sometimes required in the treatment of chronic cystitis. Dr. Emmet[1] performs it as follows: Anæsthesia; Sims's position. A Sims's speculum is introduced into the vagina, and a director, abruptly curved an inch and a half from its extremity, introduced through the urethra. While the director is held by an assistant with its point firmly pressing

FIG. 321.



Obliteration of the vagina.

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[1] Chronic Cystitis in the Female, American Practitioner, Feb. 1872, and Vesico-Vaginal Fistula, p. 43.

in the median line against the base of the bladder a little behind the neck, the surgeon seizes the projecting tissue on the vaginal surface with a tenaculum, and exposes the beak of the director by cutting upon it with a pair of scissors. One of the blades of the scissors is then passed through the opening and a cut made backward in the median line.

If the opening tends to close spontaneously too soon, a hollow glass stud made of half-inch tubing should be buttoned into it. The vesical rim of this stud need not be more than a slight flare, the vaginal rim should be larger.

OBLITERATION OF THE VAGINA; KOLPOKLEISIS.

(Fig. 321.) When a vesico-vaginal fistula cannot be closed by the means above described, the escape of urine may be prevented by closing the vagina. Vidal de Cassis first performed this in 1833 by effecting union between the labia majora, but it has been found that complete closure cannot be thus obtained, a small opening remaining at the lower angle. Simon's method of uniting the anterior and posterior walls of the vagina instead of the labia is much more trustworthy. It was first performed in 1855.

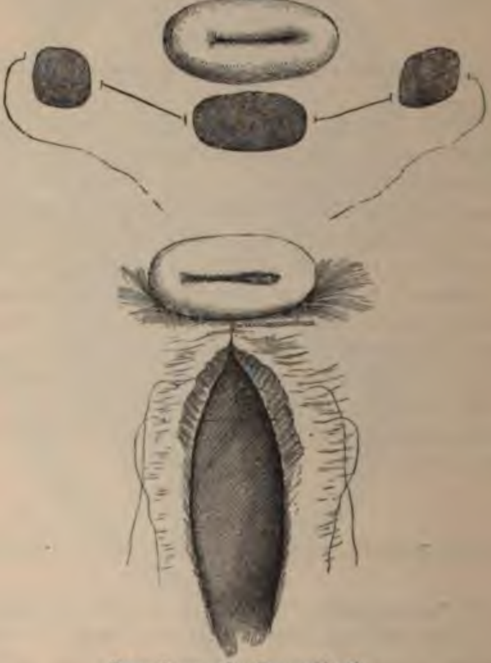
A strip of mucous membrane encircling the vagina just below the fistula is removed, the opposing raw surfaces brought together by sutures, and the bladder kept empty by a catheter until union has taken place.

ELYTRORAPHY, OR NARROWING OF THE VAGINA.

This is an operation intended to prevent prolapse of the uterus. The method, introduced by Sims, of removing a longitudinal strip of mucous membrane from each side of the vagina, and bringing the raw surfaces together, has proved not only inefficient, but often actually harmful by supplying a pouch in which the cervix became engaged, thus causing extreme retroversion. Dr. Emmet avoided this defect by closing the pouch at its upper end, but the mechanical difficulties in the way of performing the operation are so great that he has substituted for it another in which he catches up on a tenaculum three folds of the vaginal mucous membrane, one on each side, and the third in front of the cervix (Fig. 322), denudes them over a space half an inch square, and draws them together with a suture. The three folds radiating from these points are then pared, and united stitch by stitch along the anterior wall of the vagina.

Dr. Thomas suggests[1] a method which, he thinks, promises well. It may be performed upon either vaginal wall, or on both in two successive operations. While doing it, the uterus may be left in complete prolapse, or it may be previously returned to the pelvis.

FIG. 322.



Emmet's operation for procidentia.

Suppose an operation on the anterior wall, the uterus prolapsed. Dorsal decubitus. The mucous membrane of the vagina half an inch from one side of the cervix is pinched up, and a small hole made in it through which a grooved director is passed directly across the anterior face of the uterus, between it and the vagina, to the corresponding point on the other side of the cervix. Upon this director the vagina is cut transversely. The director is again entered at the centre of the transverse incision, worked up through the loose areolar tissue between the bladder and vagina nearly to the meatus, and then withdrawn. A steel instrument (Fig. 323), as large as a No. 9 sound, with blades three inches long, is passed along the channel made by the director and opened forcibly so as to tear the subcutaneous tissue and separate the bladder from the vagina over a triangular space, the apex of which is near the meatus and the base at the cervix.

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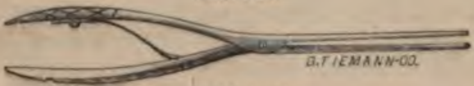
[1] Diseases of Women, 4th edition, p. 354.

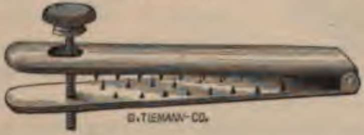
FIG. 323.



Thomas's dilating forceps.

The ends of the transverse incision are then brought together by a suture, the result being that the loosened triangular portion of mucous membrane hangs down and forms a longitudinal fold; this fold is engaged between the blades of a toothed clamp three inches long and half an inch wide (Fig. 324) placed with its hinge at the cervix and tightened by means of the screw. Then the portion of the vaginal mucous membrane hanging out of the clamp is cut off, the edges of the wound brought together with interrupted silver sutures, and the uterus returned with the clamp still in place. The vagina is then firmly plugged with cotton,

FIG. 324.



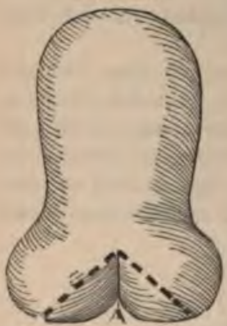
wet with a solution of alum and carbolic acid, to prevent hemorrhage; this plug should be removed at the end of twenty-four hours, the clamp after forty-eight hours, and the sutures in eight or nine days.

For the operation upon the posterior wall of the vagina, or when the uterus is in place, the transverse incision at the cervix should not be made, the dilating forceps being passed in the opposite direction.

LACERATED CERVIX.

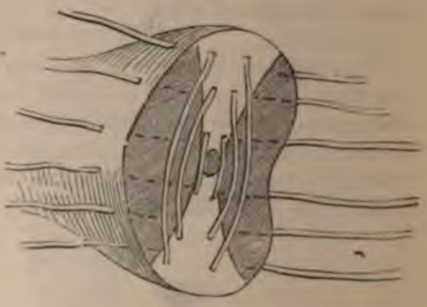
Dr. Thomas Addis Emmet[1] was the first to point out that after laceration of the cervix the lips rolled out, their mucous membrane became eroded by contact with the floor of the pelvis, and that the proper method of treatment was to freshen the torn surfaces and bring them together with sutures, so as to restore to the cervix its normal size and form. In cases which have long remained unrecognized or untreated, the lips become centrally enlarged by the inflammatory process, so that they cannot be properly brought together until after the removal of a thick piece on each side of the inside of each lip (Figs. 325 and 326). In

FIG. 325.



Lacerated cervix. Side view.

FIG. 326.



Lacerated cervix. Showing denuded surface (the shaded part) and sutures.

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[1] American Journal of Obstetrics, Nov. 1874.

like manner, when the eversion is increased and the coaptation of the lips prevented by cystic degeneration of the mucous follicles lining the cervical canal, and by vascular engorgement due to the inflammation and to a constriction by the everted edge of the cervix, similar to that observed in paraphimosis, free punctures must be made with the point of a knife to let out the blood and the contents of the cysts. It is well to do this several days or weeks before the operation, apply tincture of iodine to the cervix, and bring the lips together temporarily by putting a plug of cotton into the posterior cul-de-sac and leaving it there for several hours at a time. The puncturing and application of iodine must be frequently repeated until the cysts shall have all disappeared and the erosions become nearly or entirely healed.

The patient is placed on her left side, a Sims's speculum introduced, and a loop of wire placed around the cervix above the vaginal reflection and tightened by drawing its ends down through a canula so as to prevent bleeding; or an injection of hot water just before the operation will answer the same purpose. The lips are then separated and the lacerated surfaces thoroughly freshened with curved or angular scissors or a knife, leaving a broad undenuded strip in the centre to form the lining of the restored canal. This strip should be shaped somewhat like an hourglass in order to allow for the shrinking of the cervix which follows the operation (Fig. 326). The freshening should be done from below upward, so that the blood may not interfere, and must be carried deeply enough to remove all diseased glands and follicles.

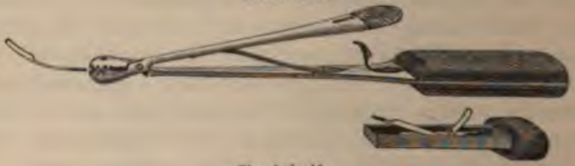
A tenaculum is then engaged in each lip, and the two drawn together; if proper coaptation is prevented by the central enlargement of the cervix above mentioned, simple freshening of the surface is not sufficient, but a greater thickness of tissue must be removed. The freshening at the angles of the fissure should be superficial, so as not to involve the circular artery which often lies just at that point.

The sutures should be of silver wire, and passed with a short, round needle if the tissues are soft, or with a lance-shaped one if they are dense and indurated. From three to five will be needed on each side if the laceration is extensive and double. The first one on each side should be entered just beyond the angle of the fissure so as to include the branches of the circular artery if necessary. The needle is entered on the outside of the lip and brought out at the edge of the undenuded strip which is to form the canal, and then passed in the opposite direction (from within outward) at corresponding points through the other lip. Care must be taken to obtain accurate approximation along the vaginal edge, but the inner edges of the denuded surfaces do not require attention.

POSTERIOR SECTION OF THE CERVIX.

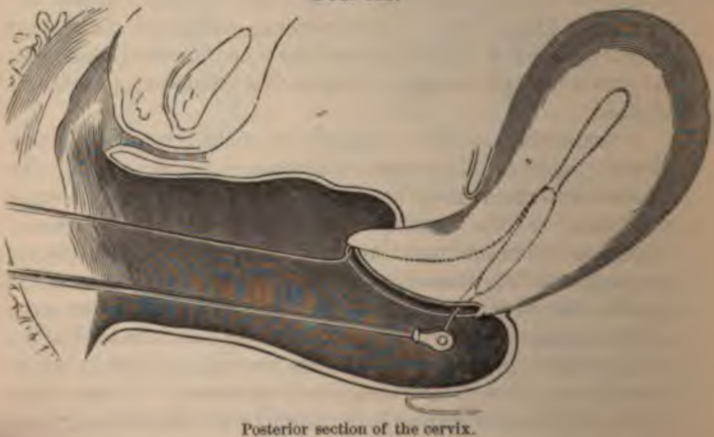
This operation may be rendered necessary by irreducible flexion of the uterus. The patient being placed in position

FIG. 327.



Sims's knife.

FIG. 328.



Posterior section of the cervix.

and a Sims's speculum introduced, the cervix is fixed by a tenaculum and its posterior lip divided with scissors as high as to the vaginal junction. The blade of a Sims's knife (Fig. 327) is then introduced through the os internum, and the tissues cut so as to lay open the posterior wall of the cervix (Fig. 328). The blade is then turned toward the anterior wall, and the little shoulder which, as Dr. Emmet has pointed out, usually exists there at the point of flexion is cut through. Instead of making this second incision Dr. Wylie practises and recommends divulsion with a strong steel dilator.

A roll of cotton saturated with a solution of persulphate of iron, one part to two of water, is placed so as to occupy the whole cervix, and retained by a plug of wet cotton in the vagina.

AMPUTATION OF THE CERVIX UTERI.

The cervix may be removed with the bistoury or scissors, the écraseur, or the galvano-cautery.

Bistoury or Scissors.—The patient is placed in Sims's position, the speculum introduced, the cervix slit transversely, and each lip seized in turn with forceps, and cut off as near the vaginal junction as is considered proper. The mucous membrane of the interior is then drawn down and made fast with silver sutures to the outer edge of the cervix so as to cover in the raw surface. The hemorrhage is often very severe.

Écraseur.—Dr. Thomas advises that if the uterus is prolapsed, or if the cervix can be protruded by moderate traction, the patient should be placed on her back, otherwise in Sims's position. No difficulty will be experienced in passing the chain of the écraseur, but great care must be taken that it does not drag upon the neck without cutting, since it sometimes draws in the peritoneum or bladder.

Galvano-cautery.—Dorsal decubitus, or Sims's position. The wire is passed around the neck and tightened until it is so firmly fixed that it will not slip. The current of electricity is then passed through it, and the wire tightened by a screw as it burns its way through. Dr. Thomas considers this method greatly superior to the others.

OVARIOTOMY.

.The steps of the operation are:

- Incision into the peritoneal cavity.
- Search for adhesions.
- Tapping of the cyst and rupture of adhesions.
- Removal of the sac, and treatment of the pedicle.
- Cleansing of the peritoneum.
- Closure of the external wound.

Four or five assistants are needed: one to stand opposite the operator, make pressure on the abdominal wall, and aid in manipulating the tumor; a second to administer the anæsthetic; a third, fourth, and fifth to tie ligatures, hand instruments, clean sponges, and make pressure on the abdomen if necessary.

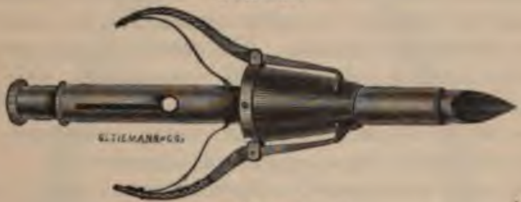
The patient should be prepared for the operation by taking a gentle laxative every second day during the preceding week and enough opium the night before to insure a good night's rest. The temperature of the room should be between 75° and 80° Fahrenheit, and the patient should be dressed in flannel drawers, wrapper, and stockings. Dorsal decubitus, with the legs hanging down over the end of the table and the feet resting on chairs.

Incision.—The incision should begin in the median line about six inches above the symphysis pubis and extend about five inches downward. The tissues are divided layer by layer, and the bleeding arrested as it occurs. When the linea alba is reached it must be pinched up, opened, and divided upon a director, and then the underlying peritoneum opened in the same manner. It is not always easy to recognize the peritoneum or the cyst; each has been mistaken for the other, and as the disadvantages of opening the cyst prematurely are far less serious than those of separating the peritoneal from the abdominal wall, Prof. Peaslee[1] lays down the rule that whenever there is any doubt about it the surgeon must act as if the peritoneum had not been opened. He also advises that the incision into the peritoneum should not at first be more than an inch and a half long, since that is sufficient to disclose broad lateral or anterior adhesions if they exist, and, generally, to complete the diagnosis if it has been doubtful; in short, the incision should be considered an exploratory one, until it has enabled the surgeon to decide whether or not to complete the operation.

Search for Adhesions.—This is made with a steel urethral sound previously dipped in hot water, which is introduced through the incision and swept around the cyst. It should not be used to break the adhesions, but only to determine their position, number, and size, and to complete or verify the diagnosis, for this is the point at which the operation must be abandoned, if at all.

Tapping the Cyst and Rupture of the Adhesions.—Prof. Peaslee preferred "the simple trocar of various sizes (three to five lines in diameter) and five inches long;" Dr. Thomas[2] uses Spencer Wells's large trocar (Fig. 329) if "it is absolutely certain that the tumor is an ovarian cyst, and that the prospects are decidedly in favor of its susceptibility of removal." Whatever kind of trocar is used, a rubber tube should be attached to it to carry the liquid to the receiving vessel. The trocar should be introduced at

FIG. 329.



Spencer Wells's trocar.

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[1] Ovarian Tumors, p. 421.
[2] Diseases of Women, 1874, p. 746.

the upper angle of the incision, and the assistant should make pressure upon the abdominal wall as the liquid runs off, and should fill the incision with sponges to catch any that may escape alongside the trocar.

If there are other cysts, they may be evacuated through the original puncture by reinserting the trocar into the canula and pushing it on into them; if any difficulty is experienced in doing this, Spencer Wells advises that a free incision be made in the first cyst, and the hand passed through it to grasp and steady the others while they are punctured.

If adhesions exist some may be broken before the evacuation of the contents of the cyst and some afterward; if the tumor is a monocyst and the adhesions slight, the steel sound may be used to break them, but if they are extensive and vascular other measures are required, such as tearing with the hand or dividing with scissors, the écraseur, or the cautery.

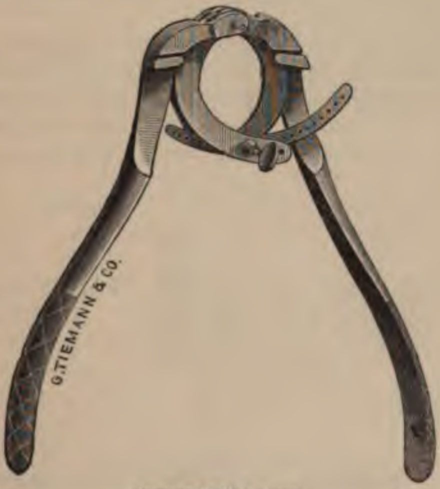
The hand, as also any instrument, must be dipped in hot water (98° Fahr.) before it is passed into the cavity of the abdomen. Prof. Peaslee says the fingers of the surgeon are the most trustworthy instruments for detaching parietal or omental adhesions, and all others of a certain length; the main precaution is to detach them from the surface of the cyst and not from the peritoneum. Adhesions between the cyst and the intestines or pelvic organs, on the other hand, are best divided by scissors. The actual or galvano-cautery is used by some in order to avoid hemorrhage. Dr. Peaslee objects to the actual cautery because particles of the oxide of iron are left behind, which, as foreign bodies, are open to the only objection urged against silk ligatures.

If the cyst is intimately adherent to any organ, it should not be detached, but the adherent portion of the cyst wall should be cut away from the rest and left attached to the viscus, or, as Dr. Peaslee suggests, the peritoneal lining should be divided all around the adhesion and the fibrous layer peeled off. If the first plan is adopted, it is proper to dissect off the free, or secreting, surface of the adherent portion. If bleeding follows the division of an adhesion, an antiseptic silk or catgut ligature must be applied. If the bleeding comes from a surface denuded of its peritoneum, and is not arrested by exposure to the air, pressure, or ligation, the position of the vessel which supplies it may be ascertained by making pressure at different points around the margin of the surface, and a fine ligature passed under it with a needle. In one case Dr. Peaslee pinched up a fold of the abdominal wall, including the bleeding surface, and passed sutures through it on the outside, thus stopping the hemorrhage by the pressure of the two sides against each other. The sutures were removed at the end of the third day.

Omental adhesions must be divided between two ligatures.

Removal of the Sac and Treatment of the Pedicle.—If the sac cannot be readily withdrawn after the adhesions have separated, no force must be used, but a search made for the cause, enlarging the abdominal incision upward if necessary. During these manipulations and the examination of the pedicle, Dr. Peaslee prevents leakage from the sac by not withdrawing the canula, but, instead, reinserting the trocar into it and forcing it again through the cyst wall from within outward, a few inches from the original punc-

FIG. 330.



Spencer Wells's clamp.

ture. The trocar is then withdrawn and the canula tied in by throwing a strong ligature around the cyst below its two ends. The canula thus forms a sort of handle, and no liquid can escape. Dr. Thomas prefers to place a ligature or a temporary clamp around the sac at some distance from the pedicle and then cut the sac away.

The pedicle may be brought out at the lower angle of the incision and secured with a clamp or ligature, or it may be transfixed with a double ligature and returned, the ends of the ligature having been cut short. Many other methods have been employed, such as ligation or torsion of the different vessels, acupressure, actual cautery, and the écraseur, for a full description of which the reader is referred to special works on the subject. Practically, the numerous methods are narrowed down to the ligature or clamp for long pedicles, the ligature for short ones, and enucleation when there is no pedicle.

Ligatures should be of silk, and in applying them the pedicle should be separated into two or even three parts, according to its breadth, two if the breadth is four inches, three if it is six inches. It is well to have the loops include each other, as shown in Fig. 331. They are most readily applied by transfixing the pedicle with a mounted needle, having its eye at the point, and armed with a fine silk thread, in the loop of which the end of the ligature is engaged (Fig. 332) and drawn back through the pedicle. According to Dr. Peaslee the needle should be passed at least three-quarters of an inch from the cyst, keeping also about the same distance from the uterus, and above all avoiding the plexus pampiniformis. There must be no traction upon the pedicle at the time the ligatures are tied, other-

FIG. 331.

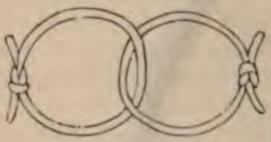
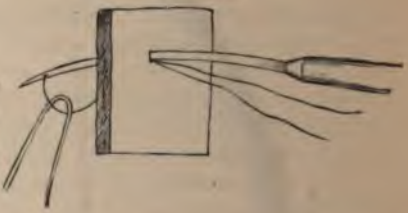


FIG. 332.



wise it may slip through them. Tie the ligature very tightly, cut the pedicle three-quarters of an inch from it, leave the ends of the ligatures long until ready to close the incision, then cut them short and let the pedicle fall back to its natural position, or bring the stump into the lower angle of the wound and fix it there by transfixion with two long stout pins. In holding up the pedicle for examination, or while cleaning the cavity, do not make traction upon the ligatures; hold up the pedicle with a tenaculum inserted in the stump, on the *distal* side of the ligature, of course.

Enucleation is required when there is no pedicle, especially in cases of solid or semi-solid tumors Dr. Thomas[1] describes it as follows: The operator, cutting through the sac, passes his hand and arm in and discovers the lowest portion of the sac. Then near the base of the sac he picks up the peritoneal covering, cuts through it, passes in his finger, and removes the tumor by enucleation. The sac which is left should then be opened, thoroughly cleansed, touched all over its oozing surface with persulphate of iron, and, if large, tied around a catheter, which will act as a drainage tube.

Cleansing of the Peritoneum.—The remaining ovary must next be examined, and, if seriously diseased, removed. Cysts not larger than a cherry may be safely punctured and the ovary left.

It is a matter of the utmost importance that all liquid should be removed from the peritoneal cavity; it is not probable that the manipulations required to effect this materially increase the chance of the occurrence of peritonitis, while it is very certain that if any liquid is left it is likely to undergo decomposition and give rise to septicæmia. Carefully purified sponges of small size and firm texture should be used, and it is well to use not more than two or three such, and in any case to count beforehand the number used, so as to guard against leaving any within the peritoneal cavity.

Closing the External Wound.—Before closing the external incision Dr. Sims passed a drainage tube through the posterior cul-de-sac into the vagina; Dr. Peaslee was the first to employ this method, in 1855, but he afterward discarded it entirely, as not only ineffectual but dangerous. He used instead, whenever he had reason to anticipate a speedy accumulation of liquid, a silver tube one-quarter of an inch in diameter and about five inches long, introduced through the lower angle of the incision into the posterior cul-de-sac. A long strip of linen was packed inside the tube, projecting about an inch beyond the lower end to protect the abdominal organs from contact with the edge. Dr. Thomas uses a glass tube half an inch in diameter and eight inches long, applied in the same manner as Dr. Peaslee's. If septicæmia occurs he inserts a gum-elastic catheter through the tube, withdraws the latter an inch and injects a stream of warm water containing a drachm of chloride of sodium or sixteen grains of carbolic acid to the pint, until the return current runs clear.

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[1] Diseases of Women, 1874, p. 753.

The external wound is finally closed by two sets of metallic sutures, the deep and superficial. The former may be passed by means of the needle employed by Dr. Peaslee to transfix and tie the pedicle (Fig. 332), or by threading each end of the wire upon a needle and passing it from within outward. The sutures should pass through the peritoneum near the edge of the incision and emerge through the skin about an inch from the edge, and should then be tied over ivory rods or pieces of gum catheter (quilled suture). By including the recti muscles in these sutures, the patient is rendered less liable to hernia in the line of the incision. The superficial sutures may be interrupted or twisted, and should include only the skin and subcutaneous cellular tissue. Some surgeons use only one set of interrupted sutures, including the skin and peritoneum, and placed about half an inch apart; others close the peritoneal opening by a continuous catgut suture, and include in the silver sutures only the skin and muscular layers.

Finally, two or three strips of adhesive plaster five inches wide are wrapped entirely around the abdomen, and an antiseptic dressing applied.

VAGINAL OVARIOTOMY.

(Thomas.) The rectum must be thoroughly emptied, not merely by an enema, but also by the finger if necessary. The patient is then anæsthetized and placed in Sims's position. A Sims's speculum is introduced, a fold of the vaginal wall caught up on a tenaculum in the posterior cul-de-sac close to its reflection upon the cervix, and an antero-posterior incision, nearly an inch long, made in it in the median line with a pair of scissors. The point of the tenaculum is then disengaged, passed into the incision, and reëngaged in the areolar tissue between the vagina and peritoneum. The surgeon cuts carefully with the scissors between the tenaculum and uterus, not antero-posteriorly but in a direction parallel to the posterior face of the uterus, changing the position of the tenaculum as the depth of the incision increases, until he has reached and opened the peritoneum.

He introduces his finger through the opening, and brings down the tumor or ovary of which he is in search; or enlarges the opening transversely by tearing, if necessary, and introduces the whole hand.

The only operative risk is that of cutting into the rectum; and this may be avoided by remembering that, although the peritoneum forming Douglas's cul-de-sac usually descends along the upper portion of the posterior wall of the vagina to a greater or less distance (more than an inch, according to Tillaux;[1] less than half an inch, according to Sappey[2]), it sometimes does not cover it at all, and, therefore, the dissection must be made, not directly backward, but upward and inclining somewhat backward from the line of the uterus. It must also be remembered that the thickness of the vagino-peritoneal septum is often quite considerable. This operation is now practically abandoned because disease of the ovary is commonly accompanied by disease of the Fallopian tubes.

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[1] Traité d'Anatomie Topographique, p. 966.

[2] Anatomie Descriptive, vol. iv. p. 749.

VAGINAL HYSTERECTOMY (SCHROEDER[1]).

Having dragged the uterus forcibly downward with Muzeux's forceps, he cuts into the connective tissue in front of the whole width of the anterior lip of the cervix, and separates the bladder from the cervix, then cuts through the posterior vaginal vault, so that the cervix is freed on all sides, and opens Douglas's space. Cutting with scissors, he extends the opening to the utero-rectal ligaments, and introduces two fingers into the cavity, over the uterus, and into the utero-vesical pouch, and on them divides the peritoneum in front. By combined manipulation the uterus is retroverted, and the fundus brought through the posterior wound to the vulva by traction with the forceps. The ligation of the broad ligaments must be so managed that the ligatures will not slip when the uterus is cut away; this is quite difficult when the entire removal of the tubes and ovaries with the uterus is undertaken, but is much easier when the uterus alone is removed. Schroeder usually ties *en masse* on each side, and then applies two additional ligatures close to the first one, one for the upper, and the other for the lower part of the broad ligament. It may be best to divide the broad ligaments close to the uterus, and remove the ovaries as a separate step. The division of one broad ligament much facilitates ligation of the other.

A winged drainage tube is placed in the centre of the wound, and the lateral portions are brought together without any attempt to secure nice coaptation of the peritoneum.

HYSTEROTOMY.

(Cæsarean Section.) The preparation and position are the same as for ovariotomy. The incision should begin in the median line a little below the umbilicus, and end about two inches above the symphysis pubis. The tissues are divided layer by layer, bleeding arrested as it occurs, and the peritoneum opened upon a director, while two assistants make steady pressure upon the abdomen above and below to keep the abdominal uterine walls in close apposition.

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[1] This description, slightly altered, is taken from Emmet's Gynecology, 1884, p. 530.

As it is impossible to determine the position of the placenta beforehand, the incision of the uterus must be made in the median line between the fundus and cervix, not involving these two parts, because their circular fibres, if divided, would retract and cause the wound to gape. As the inner surface of the uterus is approached, the successive cuts must be made with caution lest the placenta should chance to lie underneath and be injured; if it is met with, the surgeon must detach it carefully on one side before attempting to remove the child.

If the membranes are intact, the escape of the amniotic liquid must be guarded against at the moment of their perforation by making the opening small, and the liquid must be prevented from running into the peritoneal cavity. The orifice is then enlarged, the child seized by the feet and extracted. The hand is passed into the uterus, the placenta detached and withdrawn, and finally a probang passed through the os into the vagina to secure an outlet in that direction for the discharges.

After the uterus has contracted down, and the peritoneal cavity has been cleaned, the incision in the uterus may be closed, as in Spencer Wells's case, by a continuous suture, the end of which is brought out into the vagina, or it may be left ununited. The abdominal incision must be closed with silver sutures as after ovariotomy.

GASTRO-ELYTROTOMY.

The operation, which now, thanks to Dr. Thomas, is again upon trial, with a fair prospect of becoming the substitute not only for Cæsarean section but also for craniotomy in some cases, was first performed by Ritgen in 1820.[1] In 1806, 1822, and 1823, the same operation was suggested independently by two other obstetricians, and attempted by a third, Baudelocque, who, however, abandoned it for Cæsarean section. Nothing more was then heard of it, except in condemnation by Velpeau, until early in 1870 when Dr. Thomas performed it upon a woman dying of pneumonia in the seventh month of pregnancy. Fortunately, the distinguished gynecologist was fully prepared for the emergency; he had conceived the plan of the operation, in ignorance of its history, several years before, and had rehearsed it upon the gravid as well as the non-gravid cadaver.

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[1] Thomas on Gastro-Elytrotomy, Am. Journ. of Obstetrics, 1871, p. 125.

Since that time it has been performed twice by Dr. Skene, of Brooklyn, and once by Dr. Thomas, with most gratifying results, as the following record shows.

First Case.—Dr. Thomas. Performed in the interests of the child, the mother being moribund at the time of operation. Child safely and easily delivered.

Second Case.—Dr. Skene. In the interests of the mother, craniotomy having been previously performed. Mother recovered.

Third Case.—Dr. Skene. Both mother and child lived.

Fourth Case.—Dr. Thomas. Both mother and child lived.

Dr. Thomas describes the operation as follows:[1]

1. The operator should be provided with a pocket case of instruments, a blunt hook, steel sound, cautery irons, ether, persulphate of iron, and Barnes's dilators.

2. The patient, having been anæsthetized, should be placed on a firm table, and the os fully dilated by Barnes's dilators.

3. An incision should be made with a bistoury through the skin of the abdomen (preferably on the right side) parallel to, and a finger's breadth above, Poupart's ligament, and extending from the spine of the pubis to the anterior superior spinous process of the ilium. This incision is carried down through the different layers as for ligature of the common iliac, and when the peritoneum is reached it is pressed upward and inward, and the fingers passed down into the wound to the vagina at its junction with the cervix. A large steel sound is then passed into the vagina as far as the cervix by an assistant, the wall of the vagina pressed up into the abdominal wound, the beak of the sound cut down

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[1] Loc. cit., pp. 130 and 139.

upon, the opening enlarged with the fingers, and the sound withdrawn.

4. The cervix is drawn up into the iliac fossa by an assistant with a blunt hook, the fundus of the uterus depressed in the opposite direction, and the operator passes his right hand into the open cervix and delivers the child, turning it if the head presents, extracting it if the breech presents.

5. The iliac fossa should be cleaned with a stream of tepid water introduced through the abdominal wound and escaping through the vagina, ligatures applied to bleeding vessels, or, if that is impossible, a metallic vaginal speculum introduced through the abdominal wound, and the actual cautery carefully applied. If hemorrhage should continue after the abdominal wound has been closed by suture, the uterus should be excited to firm contraction, and a sponge, wet with a solution of persulphate of iron introduced through the vagina, and placed in contact with the bleeding point, or the vagina tamponed.

6. Should no hemorrhage occur, the vagina should be sponged out every twelve hours with a weak solution of carbolic acid.

REMOVAL OF THE FALLOPIAN TUBES AND OVARIES.
"TAIT'S OPERATION."

A small incision is made in the median line midway between the umbilicus and pubes, and carried down to the peritoneum. All bleeding is arrested, and then the peritoneum carefully opened upon a director. The index and middle fingers are passed to the fundus of the uterus, and thence along the back of each broad ligament to explore the tubes and ovaries. If the tube is found greatly distended it should now be emptied with the aspirator. If the ovary is deeply covered in by the broad ligament it can be readily exposed by unrolling the ligament from behind forward.[1] If there are adhesions they must be gently separated, or tied and cut; it will perhaps be necessary to enlarge the abdominal incision for this purpose.

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[1] Wylie, Dis. of the Fallopian Tubes, p. 20.

If the ovary is free, or after it has been freed, it is drawn into the incision, and the loop of a double antiseptic silk ligature passed through the broad ligament below it and divided; the two ligatures are then crossed and tied, one on each side, and the ovary and tube cut away. The peritoneum must then be most carefully cleaned, and the abdominal incision closed, as described under Ovariotomy.

CHAPTER IX.

MISCELLANEOUS OPERATIONS.

SPLENOTOMY.

As this operation has only been performed a few times, and under circumstances which greatly altered the normal anatomical relations of the parts, it seems more desirable to describe the operations as performed than to attempt to lay down formal rules for its performance. In Péan's first case,[1] Sept. 6, 1867, the operation was begun under the impression that the tumor which it was designed to remove was an ovarian cyst. The incision was made from the umbilicus to the symphysis pubis, the omentum was found covering the tumor, and so adherent that the cyst had to be punctured through it. As soon as it became clear that the cyst was not connected with the pelvic organs the incision was carried four finger-breadths higher along the left side of the linea alba, and when it was found to have its origin in the spleen, the gastro-splenic omentum was tied in four parts with metallic ligatures and divided with the actual cautery. The ligatures were cut short, the abdominal incision closed, and the patient made a good recovery.

In his second case, the diagnosis of hypertrophy of the spleen was made; it was operated upon April 25, 1876, and is reported in the *Bulletin de l'Académie de Médecine* for 1876, p. 725. The incision extended from the pubes to the epigastrium; the omentum, which covered the tumor, was pushed aside and the spleen disclosed, extending from the left hypochondrium to the right iliac fossa. The gastro-splenic omentum was ligatured *en masse*, divided, and the stump brought out at the lower angle of the wound. The patient recovered.

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[1] Gazette Médicale de Paris, 1867, p. 738.

Dr. Watson[1] also removed an hypertrophied spleen weighing more than ten pounds, and the patient, a young man, recovered. Dr. Watson transfixed the gastro-splenic omentum with a double ligature, and tied it in two portions.

Professor Billroth removed an enlarged spleen, at Vienna, in January, 1877.[2] He says the operation is simpler and easier than most ovariotomies. His incision was in the median line, and extended from a hand's breadth above to a hand's breadth below the umbilicus. The tissues were divided layer by layer, and all bleeding arrested before the peritoneum was opened. The omentum and intestines, which were found lying behind the spleen, were held back with broad flat sponges, and the spleen slowly pressed out through the incision. The gastro-splenic omentum was tied in six portions with hempen ligatures, and a second set applied nearer the spleen, so that there should be no escape of blood when the intermediate portion was divided by the knife. One small artery in the omentum proved to be insufficiently compressed and required a separate ligature. The ligatures were cut short, the peritoneum cleaned of all blood and liquid, two drainage tubes passed down to the pedicle, and the external wound closed by means of thirteen deep and four superficial sutures. Four hours afterwards the patient died of hemorrhage, one of the ligatures, which included the tail of the pancreas, having slipped off.

EXTIRPATION OF THE KIDNEY.

A. *From Behind.*—The kidneys extend from the lower border of the eleventh dorsal to the upper border of the third lumbar vertebra, the right lying a little lower than the left, and the upper half or third of each is separated from the skin by the eleventh and twelfth ribs, the diaphragm and the pleura, which extends down to the lower edge of the twelfth rib, and, at the side of the spinal column, even below it (Lange). In the interval between the ribs and the ilium it is covered by the sacro-lumbalis, the quadratus lumborum, and the lower end or the aponeurotic expansion of the latissimus dorsi muscles.

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[1] Edinb. Med. Journal, Feb. 1874.

[2] Wiener Medizinische Wochenschrift, Feb. 3, 1877.

The incision is vertical, three or four inches long, and runs at a distance of about three inches from the spinous processes of the vertebræ from the twelfth rib to the crest of the ilium. Its cutaneous portion may extend above the twelfth rib, and if more room is needed a second incision may be made from the upper part of the first, outward, just below the twelfth rib for four or five inches. When the outer edge of the quadratus lumborum is reached, the outer portion of this muscle may be divided, the sides of the wound strongly retracted, and the fascia transversalis incised.

The kidney, thus exposed, is carefully separated from the surrounding fat, and a strong silk ligature thrown over it to tie the renal vessels and the ureter *en masse*, and the kidney cut away, leaving a small portion of its substance attached to the stump of the vessels to prevent the slipping of the ligature. If the bleeding still is free the wound should be packed.

B. *From in Front.*—The incision may be made in the median line above or below the umbilicus, or at the outer edge of the rectus muscle. The latter seems preferable. After division of the abdominal wall in the usual manner and with the usual precautions, the intestines are held aside with broad retractors, the peritoneum covering the kidney scratched through and detached along its anterior surface, and a ligature passed with an aneurism needle around the renal artery and tied; a second ligature *en masse* is then thrown around all the vessels and the ureter on the distal side of the first. The kidney is then separated from its enveloping fat and removed.

The gap left by its removal may be drained posteriorly through the loin, the peritoneum closed over it with a continuous catgut suture, and the abdominal wound closed; or a drainage tube may be passed from the anterior incision, across the peritoneal cavity, into the gap.

Dr. W. S. Halsted stitched the sides of the opening in the peritoneum covering the kidney to the corresponding sides of the anterior peritoneal opening, so as to shut off the peritoneal cavity during the remainder of the operation and the repair of the wound.

FIXATION OF A MOVABLE KIDNEY.

This is done through the vertical lumbar incision above described. After the kidney has been exposed it is stitched fast with catgut or antiseptic silk sutures to the divided edges of the fascia in the wound.

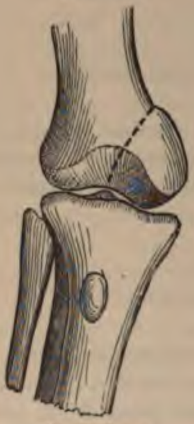
SUBCUTANEOUS OSTEOTOMY.

Genu Valgum.—Ogston, of Aberdeen, Scotland, in a paper read April 4, 1877, before the Deutsche Gesellschaft für Chirurgie meeting at Berlin, and printed in Langenbeck's *Archiv*, 21st vol. p. 542, proposed the following operation for the relief of the deformity known as genu valgum.

A small sharp-pointed knife, five millimetres broad and seven centimetres long, is entered six or seven centimetres above the tubercle of the adductors on the inner condyle of the femur, exactly in the median line of the inner surface of the thigh, and passed obliquely downward and outward across the front of the condyles, the edge directed toward the bone, until the point reaches the groove between the condyles within the cavity of the joint (Fig. 333). The knife is then withdrawn, and made to cut down to the bone on its way out, enlarging the cutaneous incision to eight or ten millimetres.

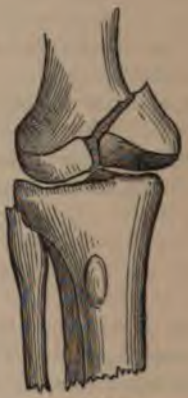
A narrow, pointed saw is then introduced carefully through the incision. When the patella is dislocated outward, the point of the saw can be felt in the groove, but if the patella is not dislocated, it must be lifted up and the point of the saw passed under it. The bone is then sawn nearly through with short careful strokes directly backward, care being taken to cut the harder shell at the upper end of the line of section to the same extent as the softer bone. When the section is thought to have nearly reached the posterior surface of the bone, the saw is withdrawn, and the condyle broken off and pushed upward by straightening the tibia on the femur (Fig. 334). The wound is closed and the limb put up in plaster.

FIG. 333.



Genu valgum.

FIG. 334.



Genu valgum.

This operation has now been superseded by transverse division of the shaft close above the condyles.

Shaft of a Long Bone.—This is an operation which has recently come into favor, and has been extensively practised in England and Germany, especially to correct rachitic deformities. The names of Maunder and Adams are especially associated with it in the former country, those of Billroth and Nussbaum in the latter. In France, the operation was brought before the profession by a paper sent to the Société de Chirurgie,[1] by Boeckel, of Strasburg, containing an account of nine cases of his own and twenty-five others which he had collected. All had been successful. In the discussion which followed Tillaux's report upon this paper, the surgeons generally expressed themselves in favor of the operation, but thought the preference should be given to straightening by mechanical means whenever the bones are soft enough to yield.

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[1] Bulletins de la Société de Chirurgie, 1876, p. 167.

The operation is performed by making a straight incision down through the soft parts and periosteum, then raising the edges of the latter sufficiently to allow the chisel to be applied, and cutting through the bone with a few blows of a mallet. The chisel is to be preferred to the saw.

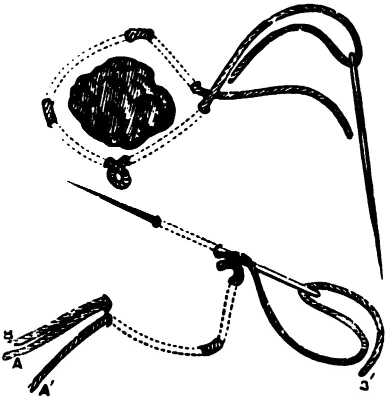
Billroth makes only a partial section with the chisel, and completes it by breaking the bone after the external wound has healed. It must be determined by the peculiarities of each case whether the incision shall be upon the concave or the convex side of the bent bone; if upon the concave, shortening is avoided; if upon the convex, a wedge of bone may have to be removed.

For the application of this operation to deformity at the hip, see *Anchylosis of the Hip-joint*, page 166.

ERECTILE TUMORS.

The usual methods of treating erectile tumors are by the ligature, caustic, cautery, and coagulating injections.

FIG. 335.

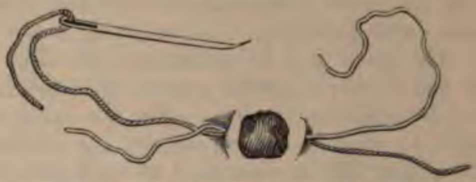


Subcutaneous ligature of nævus.

Physick cured one upon the finger by circumscribing it with a deep incision.

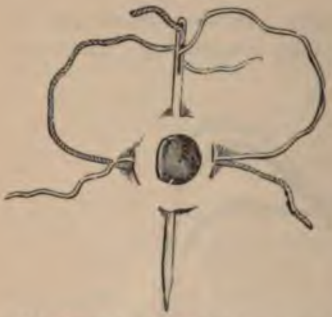
Ligatures should be so applied as to cut off the supply of blood entirely. Figs. 335, 336, 337, 338, and 339 represent good methods. The caustic treatment is applicable to small nævi; nitric acid, or the acid nitrate of mercury, may be used. The actual cautery is applied by passing white-hot needles into or through the tumor; sometimes a very disfiguring scar results. Coagulating injections usually give good results, but the method is considered dangerous on account of the possibility that the coagulation may extend into the larger vessels, and give rise to embolism.

FIG. 336.



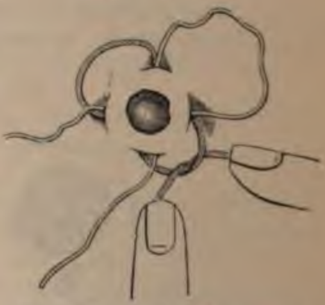
Subcutaneous ligature of nævus. The needle passed under the tumor; one thread divided.

FIG. 337.



The other end of the divided thread passed into the needle's eye, and the needle passed through at right angles to its former direction.

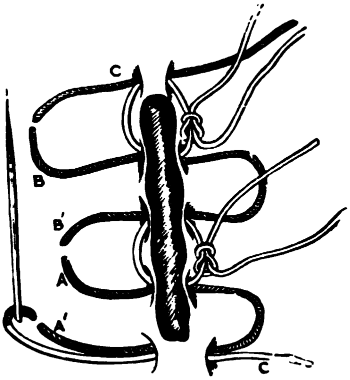
FIG. 338.



The needle removed and the nævus strangulated in quarters.

The solution, persulphate of iron, should be injected, three or four drops at a time, at several points by means of a hypodermic syringe; or the nævus may be incised longitudinally and the iron applied directly to the surface of section.

FIG. 339.



Ligature of large nævus. The white loops are divided on one side and the black on the other, and the corresponding ends AA' and BB' tied together.

BIRTH-MARK.

Balmanno Squire[1] has introduced a very simple method of removing "portwine birth-marks." He freezes the spot with the ether spray and makes a number of fine parallel incisions from one-thirty-second to one-sixteenth of an inch apart, and extending about half through the skin, or at most to the depth of one-sixteenth of an inch. A piece of blotting paper is then laid over the incisions and pressed steadily down upon the skin for five minutes, with just enough force not to cause the incisions to gape. In twenty or thirty minutes the blotting paper must be thoroughly wet with cold water and removed by pulling it in the direction of the cuts; the underlying thin film of blood clot must also be gently and patiently washed off with a camel's hair brush. If this is properly done no bleeding will occur and no scar will be left, while if the clot is not removed it is likely to cause suppuration and prevent primary union. In some cases it is necessary to make cross-markings at right angles to the first to effect a complete cure.

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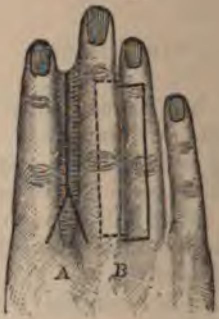
[1] Essays on the Treatment of Skin Diseases, No. III. London, 1876.

SEPARATION OF WEB-FINGERS.

Experience has shown that simple division of the membrane uniting the two fingers is insufficient, because reunion, beginning at the angle, is certain to extend over the whole length of the incision. A simple way of overcoming this difficulty is to pass a leaden or silver wire through a puncture made at the interdigital angle, keep it there until cicatrization has taken place around it, as around an earring, and then divide the membrane. The angle being already cicatrized, the lateral wounds heal separately.

Another plan is to mark out a palmar and a dorsal triangular flap at the interdigital angle, its apex turned toward the ends of the fingers (Fig. 340, A), then to split the remainder of the membrane longitudinally, pare off the end of the triangular flaps, and unite them in the interdigital angle. By this means a bridge of integument is formed which prevents reunion of the sides.

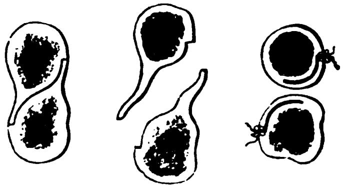
FIG. 340.



Web fingers.

These two methods answer very well when there is a distinct interdigital membrane, but some other is required when the fingers are closely approximated. The one which yields the best results is represented in Fig. 340, *B*, and Fig. 341.

FIG. 341.



A rectangular flap is dissected up from the dorsum of one finger, and a similar flap from the palmar surface of the other finger, each being left adherent by its long side. The fingers are then separated and each flap turned in to cover one of the raw surfaces.

CICATRICIAL FLEXION OF THE PHALANGES.

The cicatrix must be divided thoroughly to allow complete extension, and then if skin flaps can be obtained from the sides they may be turned in to cover the palmar surface opposite the joints. In dissecting up the flaps care must be taken not to go deeply enough to involve the artery which runs along the side, otherwise the end of the finger may slough.

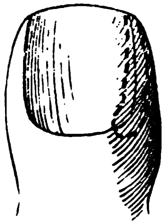
Instead of small lateral flaps for the flexures of the joints the skin covering the sides of the finger may be mobilized by lateral or dorsal longitudinal incisions and brought together in the median line of the palmar surface, the gaps created on the sides by their removal being left to heal by granulation.

Permanent flexing of the finger upon the hand, when due to retraction of the palmar fascia, must be treated by subcutaneous or open division of the fascia.

INGROWN TOENAIL.

If a cutting operation is undertaken the entire nail must be torn off and the portion of the matrix adjoining the enlarged and indurated border cut away. Local anæsthesia is obtained by applying a mixture of pounded ice and salt to the toe, or by the ether spray; one blade of a stout pair of scissors is forced under the nail, its edge turned upward, and the nail divided along the median line. Each half is then wrenched out with strong forceps, and the angle of the matrix and the thickened skin along the side of the nail dissected off (Fig. 342). In mild cases it is sometimes sufficient to excise a wedge-shaped piece from the centre of the fold of the skin by two longitudinal incisions, and draw the sides of the gap together by a suture or strips of adhesive plaster.

FIG. 342.



Ingrown toenail.

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